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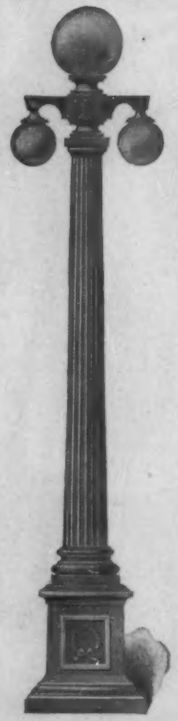

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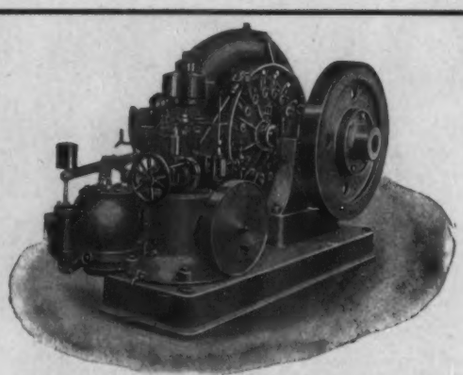

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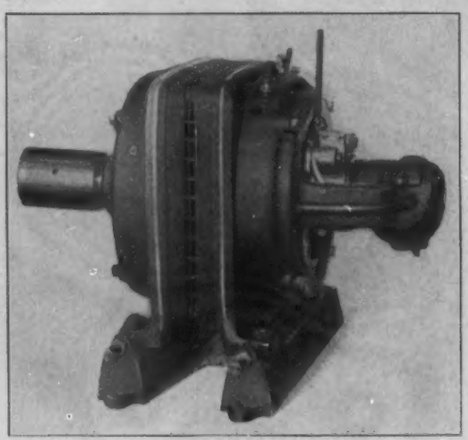

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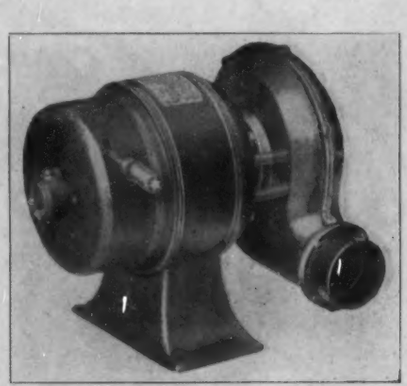

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POWER AND GAS
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VOLUME XXIV SAN FRANCISCO, JANUARY 29, 1910 NUMBER 5

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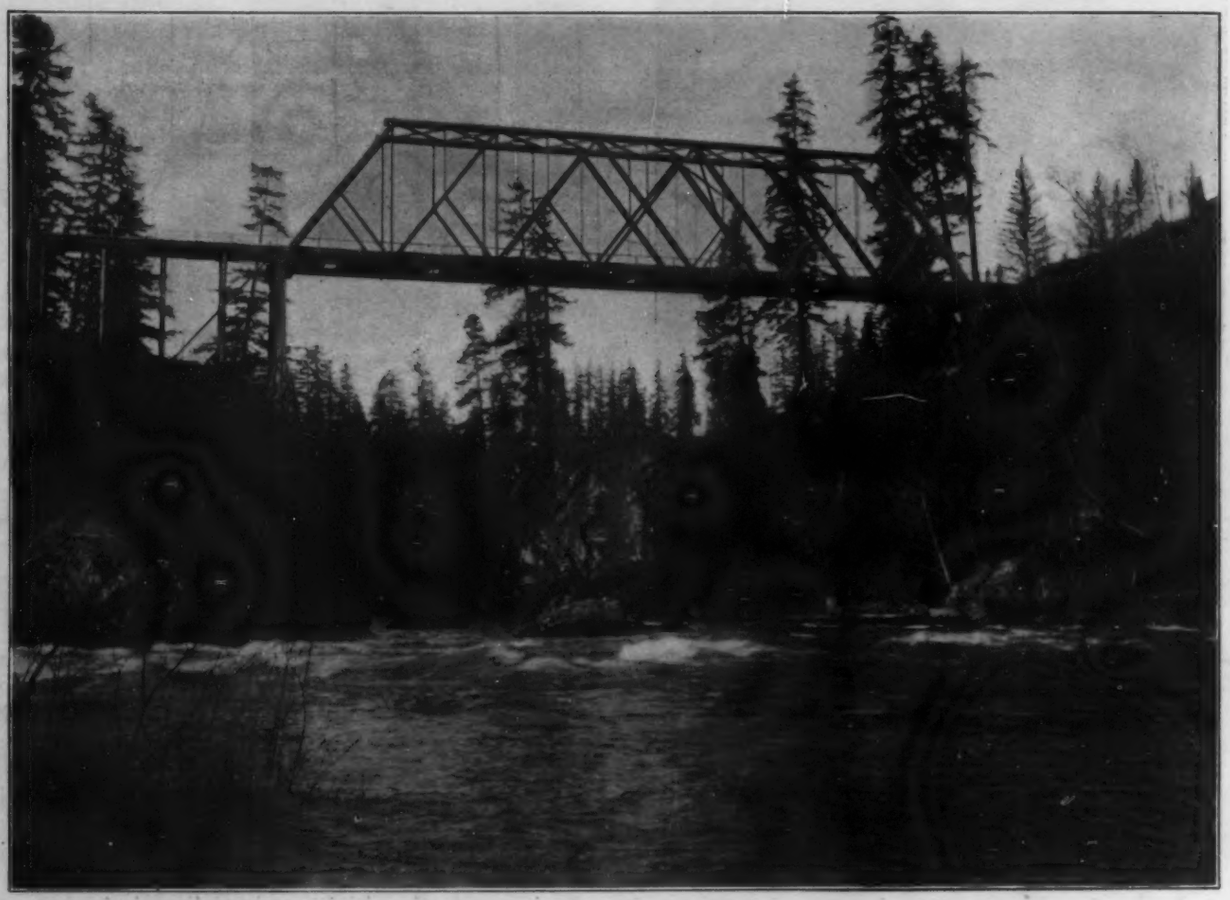
POWER DEVELOPMENT OF THE CLACKAMAS RIVER

There are few western rivers whose potential power is to be more fully developed than that of the Clackamas, near Portland, Oregon. The Portland Railway, Light & Power Company, in its completed and intended developments that include three plants located along a ten mile stretch of the river, will soon be generating between 50,000 and 60,000 kilowatt of hydroelectric power. These include the present plant at Cazadero, the contemplated 30,000 k. w. plant on the upper Clackamas, several miles above Cazadero, and the 12,000 k. w. power site at Estacada, two miles below, which was recently purchased from F. S. Morris of the Portland Water Power & Electric Transmission Company. These do not take into account the 5730 kilowatt hydroelectric plant at Oregon City, nor the steam auxiliary plants in Portland.



Site for 80-ft. Dam at Mill Bridge, near Estacada.

The Cazadero power house, a well lighted, reinforced concrete structure, stands on the western bank

of the Clackamas River, across which cables carry the current to step-up transformers.. The equipment includes three 5000 h. p., 42-in. Victor turbines, direct connected to three 2500 k. w. a. c. generators, and a 5500 h. p. Victor turbine direct connected by one shaft to four generators; three 1000 k. w. and one 500 k. w. machines, connected in parallel on one bus. The efficiency tests of this arrangement have proven eminently satisfactory. In addition a 6300 h. p. turbine, driving a 3750 k. w. Allis-Chalmers generator, is to be installed this year.

Water for the Cazadero plant is supplied under a head of 125 feet by means of a diverting dam, one and three-fourths miles above the power house. This dam is constructed of rock and clay-filled log crib-work, plank-covered and strongly reinforced and bulk-headed. The top of the water spillway is 51 feet above low water.

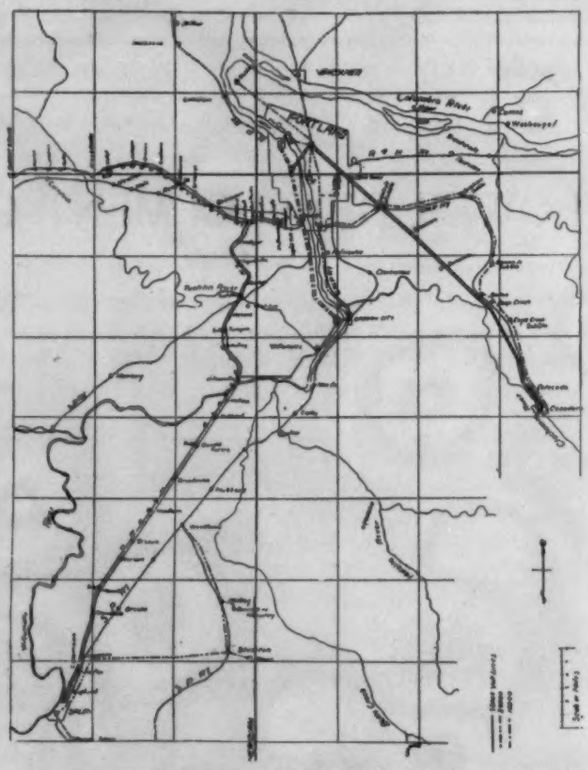
Three miles above Cazadero, where the Clackamas gorge narrows at a favorable site, a great masonry

Spillway of Cazadero Dam.

dam, 155 feet high and 750 feet long is to be constructed, the contract having been let to Sellers & Rippey. The ground has been thoroughly tested by drill holes, and the earth sluiced down to bed rock. This will give a head of over 150 feet to the entire volume of the Clackamas river, which is to be first utilized in a 30,000 k. w. plant at the foot of the dam. This, it is hoped, will be completed by September, 1913. This dam will also regulate the flow for the Cazadero plant and for the new plant below Estacada, whose 12,000 k. w. is expected to be available by September, 1911, when a new 80 ft. dam will be completed.

Two 100,000 volt steel tower transmission lines are to be built between Cazadero and Portland, the present voltage over the existing wood and pole lines being 33,000.

In addition to the steam auxiliaries at Station E and F in the city of Portland, generating 6750 and 1300 k. w. respectively, a new plant is now being erected just north of Station F on the east side of the river. The construction of this plant involves the driving of 4000 piles as a foundation and the building of an enclosing cement bulk-head. Steam is to be supplied by eight Babcock and Wilcox boilers, aggregating 3520 h. p. and arranged in four batteries of two each. These will be equipped for automatic firing with sawdust, and also for fuel oil. The prime movers include one 34 x 68 x 54 heavy duty Hoover, Owens & Reutschel cross compound engine direct connected to a 2000 k. w. d. c. generator 90 r. p. m. 20 pole, 575-625 volts for street railway service and two 2000 k. w. Curtis turbo-generator sets, furnishing 60 cycle current at 2300 volts. This plant is to be at central station for the company's whole system.



Map of High Tension Transmission Lines of the Portland Railway, Light and Power Co. and Oregon Electric Co.

On February 1, the Portland Railway, Light & Power Company will occupy its newly completed nine-story office building at Seventh and Alder streets. The company has about completed its under-ground distribution system in the business section of Portland which was started last spring.

MORE LAND WITHDRAWALS.

In the aid of proposed legislation affecting the disposition of public lands thought to be valuable for power purposes, the Interior Department has withdrawn the following areas: Territory aggregating 17,332 acres along the Clearwater river and its tributaries in Idaho, 2549 acres along the Walla Walla river in Oregon and 24,152 acres along the Sevier river in Utah. As probably containing oil, 147,887 acres in California also have been withdrawn. The total of this class of lands withdrawn in California is 1,952,453 acres. Along the Green river in Utah 11,487 acres withdrawn for power purposes have been shown to have no value as such and are restored to the public domain. The Secretary of the Interior has designated under the enlarged homestead act approximately 7320 acres in Montana as being subject to the provisions of the act.

OPPORTUNITIES, RESPONSIBILITIES AND TRAINING NECESSARY FOR SUCCESS IN THE ENGINEERING FIELD.[1]

BY W. F. DURAND.[2]

I am to speak to you this evening on the factors which make for success in the field of practical steam and power plant engineering. I shall spend little time in any attempt at a definition of success. We all have our ideas and ideals of success, as diverse as the individual point of view; but through all this diversity there runs nevertheless a common core, and I shall assume that in essence we all mean the same by this term.

In its broadest sense success must depend on the entire man—physically, mentally, morally; and on all three as bound together and made effective by the purpose and will which lie at the very center of personality. I shall assume however that I am to limit our consideration of the hour chiefly to those factors which are mental in character rather than physical or moral not forgetting however their dependence on purpose and will as the central motive power.

I shall then take as a point of departure the general proposition that success inheres primarily in the following items of the make-up of individual personality:

(1) The general content of the memory as a storehouse of facts and principles.

(2) The general quality of mentality or of mental capacity.

(3) The manner in which the raw material classified under No. 1 is made use of by the mind, and is thus made to serve the purposes of the higher intelligence.

(4) The general purpose which lies back of all conscious action and the degree of continuity and force which is put into such purpose.

Of these subdivisions we may again say that the first represents raw material, the second the equipment by means of which the raw material is to be transformed into some useful product, the third the character of the transforming operations and the fourth the purpose and will back of the entire process.

In any arbitrary classification such as that which I have just suggested, it must be understood that the partitions which separate one item from another are often wavering and ill defined, and that at best any such attempt at classification is not to be viewed as more than an aid to an orderly examination of the subject. Actually the mind is not multiple but single, working it is true in many ways and through diverse channels, and thus naturally suggesting the use of schemes of classification when its processes are made the subject of examination.

We shall then find it of advantage to consider in some detail the content and character of these four arbitrary divisions.

The general content of the memory consists broadly of two groups of items: facts and principles.

The gathering of facts always precedes the discovery of principles. Facts in themselves are bald unrelated items and bits of nature's truth. Each fact gives, so to speak, a view of some microscopic part of nature as a whole, independent and unrelated to any and all other parts. Principles serve to relate facts, to bind them together according to some common characteristic, and thus to substitute for vast collections of separate bits of information, certain broad generalizations, each one of which represents in a comparatively simple manner a whole army of separate observations or facts.

Suppose by way of illustration that a man should undertake the examination of some complicated mechanism like the linotype machine in the following manner.

We suppose him first absolutely ignorant of the existence of any such mechanism. Then let him be blindfolded and brought to the machine and allowed to inspect some small portion, such for example as could be seen through an aperture one-eighth of an inch square, all other parts being kept covered. Then let him be again blindfolded and the location of the aperture changed to some other part of the mechanism, when he is again allowed a similar restricted observation. Each of these observations might be enrolled as a fact, a certain observed state of motion or rest. But how many such observations would be required or how long time would be involved in the comprehensive study of the movements of such a mechanism, or before any adequate idea of its character or purpose could be formed. On the other hand suppose the cover removed and a comprehensive view given at once. Immediately the causes of various groups of movements are seen to lie in suitable combinations of belts, cams, levers, linkage rods, sliders, etc. A thousand separate observations might have been made on the movement of some part of the mechanism, the reason for which now appears clearly in the form of a certain cam on a revolving shaft. Thus the cam, the belt, the linkage rod, serve to bind together and to explain hundreds and thousands of movements which viewed singly and individually might forever remain an unsolved puzzle.

In a similar manner the underlying principles in nature serve to bind together otherwise disconnected facts, and to thus relieve the memory of the need of any attempt at holding them stored and ready for immediate use. The point toward which I am approaching is of such great importance that I shall venture on another illustration.

Suppose that it were desired to establish the power which can be transmitted by leather belting under all usual mechanical conditions, and without the aid of any principles or theory regarding the matter whatever. Belting may vary from three-sixteenths of an inch to three-eights of an inch in thickness and not to make subdivisions of thickness too fine we may take one thirty-second of an inch as the difference, thus giving us seven different thicknesses. Then again we may have belts varying in width from say one-half inch to fifty inches, to carry the matter no further, and varying by say one-half inch intervals. This would give us one hundred different widths. Next we may apply tensions per square inch of belt section varying let us say from one hundred to two hundred and fifty pounds by five pound steps giving thirty different values for this item. And finally we may run such belts at speeds varying from let us say

[1]Paper read before California No. 3, N. A. S. E., Dec. 1, 1909.

[2]Professor of Mechanical Engineering, Stanford University.

two thousand to five thousand feet per minute by fifty feet per minute steps, giving sixty values of the operating speed. Then it would follow, in order to cover with this degree of fineness of subdivision the field mapped out, that we should have to make the number of experiments given by the product of these various numbers, $7 \times 100 \times 30 \times 60 = 1{,}260{,}000$. Even with this million and a quarter experiments there would be no ground, without calling on principle, for the application of these results to determine any case which might chance to fall intermediate between those forming the actual field of investigation. Suppose, however, the principles clearly established relating the power transmitted, to the various characteristics of the case, and as represented by the familiar formula for power transmitted by belting. Then we have at once, in such expression of principle, the embodiment of the entire series of 1,260,000 separate experiments, as well as of any and all other possible cases for intermediate values of the variables. With the formula only a few scattering experiments will be needed to give definite values to the constants and the principles thus represented in complete form will serve for ever after as the complete representation and embodiment of numberless facts of observation.

This distinction between facts and principles which is too simple and well known, perhaps, to have required consideration at such length, is however of the greatest importance for the engineer. He must of necessity have his memory stored with both and the value of his stock of raw material will be so much the higher as it includes a wider and better assortment of each. He should however remember that the effective capacity of the memory is limited and that no attempt should be made to load it up with vast numbers of unrelated and distinct facts of observation. The engineer must remember the important part which a proper grasp of underlying principles may be made to play, and so far as possible endeavor to substitute such principles for the disconnected body of facts. As I have before noted, the gathering of facts on the part of somebody must precede the discovery of principles, but once gathered and the principle developed, the latter should be given first place.

Thus to illustrate again, it might be a fact worth remembering that an eight by ten engine with steam at 100 pounds gauge pressure, running two hundred revolutions per minute, non-condensing and cutting off at one-third stroke, will develop about twenty-five i. h. p.; but is it not of far higher value to remember the common horsepower formulae, which will tell us not only the power for this particular case, but for any and all other similar cases as well.

Again the reduction of facts to principles is not always in the quantitative form. It often takes the form of what we term understanding, or knowing the reason why. And so I repeat that, while it is of importance to store the memory with facts, it is of still higher importance to endeavor to get back of the facts and apprehend the reason why. Thus all engineers know, or should know that low carbon-dioxide in flue gases means low boiler efficiency. This is good information in its way, but it is of higher value to know the reason why; and this implies an understanding of the principles of combustion. Or, again the engineer knows that the feed water heater is a possible source of economy; also the uptake economizer. These are bits of information, valuable in their way, but it is of higher value to grasp the principle underlying all such heat exchanges in their relation to power plant economy, and which may be expressed in the following form:

"Whenever a stream of outflowing heat energy (such as exhaust steam or flue gas) can be tapped or diverted and led in whole or in part into a stream or inflowing heat energy (such as feed water or inflowing air for combustion) the net wastage of heat to the outside will be decreased and an economy will result."

The clear and effective grasp of a principle such as this is better than any mere memorization of hundreds of disconnected facts relating to this special field of engineering work.

To sum up on this point I would say:

The mere memorization of bare facts as such is the lowest use to which we can put the memory.

The effective grasp of principles and reasons why and the holding of such in readiness for immediate use, is the higher function of the memory.

Recognition should constantly be given to this higher function, and to the extent to which it may be made of aid in the reduction and classification of facts and data, and their linkage together by means of underlying principles, of which they are merely the accidental expression.

So far as it can be done however without interfering with the higher function, the memory should also be stored with well selected concrete facts and data bearing on subjects of special interest to the individual.

We may next properly ask the questions:

(1) What sources are there for the acquirement of facts and data, and for aid in obtaining a suitable grasp of the principles of which they are the expression.

(2) What means are there for cultivating and improving the memory with reference to the ready use of this material for the study of engineering problems.

Of sources we may note the following:

(a) Books, technical and trade papers, and engineering literature in general.

(b) Conversation and personal contact with those whose experience and acquirements may fit them to serve as sources of reliable information or instruction on engineering subjects.

(c) Direct courses of instruction in night school, by correspondence, or otherwise.

Of these various sources I can only speak briefly.

First we shall agree that every engineer should have a good, even though small, working library of engineering books. The man who has purpose and ambition to rise will not hesitate to invest a moderate sum in such helps, an investment which in the long run is likely to net him returns of many hundred per cent in advancement along the pathway toward success. The same is true of technical journals. Every engineer should take and read at least one good technical periodical.

Again aside from books and periodicals which will require an investment in money, there is one general

source of information which may be developed, practically without limit, at the expense of a few postage stamps. I refer to the general trade catalogue and advertising matter which manufacturers are ever ready to send on request to any engineer sufficiently interested to ask. It is true that such material is put out in the interests of some particular item of engineering equipment and that in many cases the claims of special efficiency and superiority must be taken with some allowance. In a descriptive way however such material may be made of the greatest value to the young engineer, and he will perhaps find no more instructive way in which to acquire a knowledge of the main points of many items of engineering equipment than by reading them up in their advertising literatures and then striking a fair balance among rival claims. In some cases, notably certain boiler catalogues, large sums of money have been spent in compiling engineering data of great value and presenting it in a simple and convenient manner. Such books or catalogues represent in effect a combination of text book, hand book data, and trade catalogue and may frequently be made to serve purposes of the highest utility. It is a fact recognized by all progressive engineers that the trade catalogue, especially in a descriptive way, has acquired a place of definite value in the literature of the day, and represents a source of information and instruction which we can by no means afford to ignore.

I should in this connection most strongly recommend that every engineer should provide himself with trade catalogues from at least a few well selected makers of the leading items of power plant equipment, such for example as—engines, boilers, economizers, feed heaters, pumps, condensers, steam traps, regulators, reducing valves, gauges, pipe coverings, packings, etc. In particular should he have at hand such catalogues and descriptive matter relating to the particular makes of station equipment with which he may have to deal. A sectional diagram showing plainly the make of some pump, steam trap, feed heater or other item of equipment may often be of the greatest value in understanding its operation, or in detecting the sources of derangement and trouble.

Personal contact with engineers of experience may always be made a source of information for the man anxious to profit by such opportunities. All facts are gathered in the first instance as the result of personal experience, and in getting them first hand there is often some little touch of personality included which will help to deepen the impression and make its recall more ready in time of need. So when in the company of fellow engineers do not hesitate to talk shop or to swap experiences. To those of younger years I would say, do not be afraid to ask questions. In the great brotherhood everyone should be willing to help and every one willing to learn.

Perhaps this is as fit a point as any to speak of the note book as a place for the record of one's own experiences and observations. I have already spoken briefly of the limitations of the memory and of its higher functions. Do not be afraid to supplement it by means of the note book. Almost every day and frequently many times in the day the engineer will find himself in contact with something worthy of a place in his note book. It may be some bit of information or data acquired in conversation with others. It may be some idea of his own worth jotting down for development or mature consideration at a more convenient time. It may be some little sketch of something he has seen, or of something which has just been uncovered in the process of overhaul and repair. It may be the direct result of certain observations or tests which he is engaged in making. The accumulation of years of such gathering, with occasional siftings and compilations will represents a fund of information of ever increasing value. A hand book of engineering data is of course indispensable to the engineer; but in another sense every engineer should make his own hand book, home made and representing his own accumulation of facts, data and observation.

Turning now to courses of instruction of a more or less formal character, it is self evident that where such opportunities are open to the young engineer and where his personal and family duties will permit, they should be utilized to the highest possible degree. As a rule the courses of instruction offered by night schools or by correspondence schools represent the only opportunities open to engineers in practical life, and in such cases the work must be done out of regular working hours. It will mean then a definite addition to the working day and will call for a definite sacrifice of time otherwise given to leisure and rest. This is of course unavoidable, and means no more than the application of the inexorable law that no good thing can be acquired without paying for it by sacrifice in some form. I speak of the matter here only to say that this fact of added work and sacrifice of time for leisure and rest must be clearly understood at the start, and no one should undertake such courses who is not willing to make the sacrifice required. To discuss in any detail the question of such special courses of instruction would require more time than is at present disposal. I shall therefore point out briefly that the results in general will be two fold:

(1) The student will acquire a certain amount of information of which he was previously ignorant. That is, he will add to his general stock of information and facts, with special reference to the field of engineering work.

(2) He will acquire some better knowledge of how to think, how to reason, how to study, how problems are investigated, and some general familiarity with the fundamental sources of engineering information in books, journals, transactions of societies, etc.

In short he will have acquired some addition to his stock in trade, and some new mental habits and discipline. I do not hesitate to say that the latter is by far the more important of the two. If the fact is not at hand it can be looked up in a handbook of data or reacquired from a text book; but if the mind has never been trained in habits of close analytical study and is unacquainted with the methods and means by which engineering problems are investigated, such lack cannot be made up by turning to the pages of a book or to any source outside of the mind itself. This leads to an exhortation to those who may be pursuing courses of instruction of this character, and which is, that while the bald facts of information which are presented for study should not be neglected, first

place should be given rather to a persistent and definite effort looking toward a clear grasp of reasons why, and a clear understanding of the ways and means by which engineering problems are studied. The remainder of life will be available for the gathering of facts. There is no time so valuable as that in youth or early manhood for the acquiring of correct and efficient habits of thought. The acquiring of facts, as such, can also be done without the aid of the instructor almost as well as with. The development of correct habits of thought and of proper familiarity with the ways and means best suited to the study of engineering problems can be acquired in no way so effectively as by the aid of instruction and guidance from another person. Let me close this topic then by saying that the instructor or the source of instruction should be used by the student, not as a hand book of data or an encyclopedia of information, but rather as a means of acquiring correct habits of thought and a proper familiarity with and an understanding of the ways and means best suited to the effective study of engineering problems.

This is perhaps the most suitable point for saying a word with regard to the importance of mathematics for the engineer. It is closely accurate to characterize the work of the engineer as consisting chiefly in quantitative dealing with the substances and forces of nature. Whether or not he is aware of it, he is nevertheless constantly occupied in measuring things or in doing things of which the measure or quantitative relation to other things is the item of chief importance. Now mathematics is the science of quantitative relation, and whether the engineer knows it or not he must constantly be operating with the principles and methods of this science. I am well aware that mathematics unused becomes rusty—like any other good tool—and that few practical engineers have the opportunity to acquire working familiarity with the more especially advanced methods of mathematical research. These conditions are taken for granted and I do not wish to press the point too far. I wish only to say that in general the more mathematics the engineer has at his ready disposal the more readily he will be able to deal with various problems, and the more effective will be his grasp of the subjects presented for consideration and judgment. I recall a civil engineer with whom many years ago I worked as a school boy learning something of surveying, and who used to amuse his leisure hours by solving mathematical problems, calling them "mental food." Such varieties of food are perhaps less popular at the present time, but I am well persuaded that some moments given day by day to such study, especially on the part of the young engineer, would be of far more value than equal time given to the daily paper, the cheap novel or to other forms of harmless but also fruitless amusement.

If you ask why I single out mathematics for speical notice instead of discussing the value to the engineer of various other subjects of study, I would say that it is no part of my present purpose to discuss the relation of the curriculum of the technical school to the work of the practical engineer. He would of course find material of value in all such courses of study, had he the time and opportunity to pursue them. Mathematics, however, in some measure he must use daily, and I venture to say that there is no one subject of study considered as mental discipline which is of equal importance with reference to his general effectiveness and grasp of engineering problems.

We may now turn for a few moments to the consideration of methods for improving the memory. The value of a keen and retentive memory serving as a storehouse of facts and principles, ready on the instant to supply any reasonable demand, cannot be exaggerated. How can such a memory be acquired? Time fails for any comprehensive discussion of these matters and I can only refer very briefly to certain underlying principles.

(a) The quality of memory differs much between individuals. This we must accept as a fact. The main question is how to effect improvement.

(b) The ability to call up at will the contents of the memory depends primarily on two conditions:

(1) The distinctness of the original impression.

(2) The frequency with which the original impression is revived by being called before the notice of the active upper consciousness.

It is a well established fact of modern psychology that whatever has definitely impressed the upper consciousness has gained a place in memory. This impression, however, may vary from a slight and almost vanishing touch to a record so deeply graven that nothing can serve to effectively erase. In general the original impression is the deeper and more lasting according to the degree of fulfillment of some one or more of the following conditions:

(a) Deep emotion connected with the impression.

(b) Deep and earnest concentration of attention on the subject matter to which the impression relates.

(c) A definite act of the will directed toward the deepening of the impression when first made.

Under ordinary circumstances the latter two only are available in connection with the events of every day life. To illustrate, suppose the young engineer overhears in conversation a statement of the fact that the heat value of good California fuel oil is about 18,750 heat units per pound and desires to remember such fact. He may definitely deepen the impression on the memory by some such procedure as the following:

He slowly, distinctly, and preferably with audible voice repeats to himself the number 18,750 as the heating value of oil. At the same time he visualizes the number, that is, pictures to himself how it looks. All this is done with a keen and definite concentration of attention on the number and its meaning and coupled with a focussing of will power upon the making of a deep and lasting impression on the memory.

So much for the original impression. Now with regard to recollection (the recall at will of these impressions) we find two chief aids:

(a) Repetition.

(b) Association.

Memory works most easily along accustomed channels and no matter how deep the original impression it will after a time become obscured by the more

recent content of the memory unless the earlier impression is renewed from time to time. After many renewals the impression may have gained so definite a place as to come readily at call, even after long periods of disuse. To pursue the simple example above, if the heating value of fuel oil is to be remembered and held ready for instant service, it must be brought out of the dim back ground of consciousness from time to time and the original impression renewed. Whenever the matter of the heating value of fuel oil may present itself the occasion will serve for such renewal of the original impression. If the matter does not come up in the ordinary course of events, then it should be brought up by the mind. Thus matters of any character whatever which we are desirous of remembering promptly and which we may have impressed on the memory with special concentration, should be reviewed from time to time and the impression thus renewed until the item has acquired status in that part of the memory which is under immediate and full control of the will.

Aid may also be realized by judicious use of the association of ideas. We all know how one thing will suggest another, and how a whole train of thought may spring from some one minor item as starting point. Many people make valuable use of this principle in the cultivation of the memory. I shall not attempt any discussion of the methods in detail, and only mention it in passing, leaving to each one the application to such extent as may seem effective.

We may now turn to the second principal subdivision of our subject, Quality of Mind.

We must admit, of course, that there are differences in mental endowment. Within limits the individual is not responsible for these differences. Responsibility cannot be evaded, however, for the manner of use of such endowment as we may have. Furthermore I wish to point out most emphatically that success in life in no matter what calling depends far more on the manner and extent of use than on the mere degree of initial mental equipment. Paraphrasing the scriptural parable of the talents, we may say that one talent put to use is far more effective than ten talents laid away in a napkin. I shall not attempt any survey of mental equipment in general or even of those items which might be supposed to relate especially to the work of the engineer. Time fails for such examination and there is the less need, because the basic characteristics of such equipment are beyond the control of the individual, and his larger responsibility begins with the use of such endowment as he may have, rather than with the initial character of the endowment itself. If there is any one truth in this connection, the application of which should be allowed to sink home, it is that genius is the result of mental endowment, made fruitful by untiring industry, continuing purpose and indomitable will. In the familiar phrase—"Genius is an infinite capacity for taking pains." The development of untiring industry, continuing purpose and indomitable will; the development of some capacity for taking pains, all these are within the grasp of the individual. Therefore genius in some measure lies within the grasp of him who will reach forth and take.

Again with use the quality of mental endowment will improve, new powers will develop and new achievements will come within reach.

To sum up under this head:

The individual is responsible for his basic mental equipment only to the extent to which it permits of enlargement and improvement by use. He is responsible in full for the measure and manner of use, because these depend on will, and will is the core of individuality.

Whatever may be the mental endowment therefore, let no man be discouraged. Use will bring development and growth and the history of civilization is filled with the records of men who, with only moderate mental endowment held steadfast with fixed determination, have far distanced in useful achievement others who, with higher natural endowments and advantages, have lacked the element of purpose and power of soul.

Turning from this brief reference to mental endowment as such we approach our third subdivision, the method and manner of its use.

The work of the engineer is readily divided into two principal fields:

(1) The performance of routine duties, without new elements, and in which are involved only the performance of accustomed operations, either mental or physical.

(2) The study of new problems.

While the importance of the first of these must not be forgotten, we find our chief present interest in the second division—the study of new problems.

How then shall we most advantageously approach the study of such problems? Here again we find two chief classes into which such problems are naturally divided.

(a) Those in which the desired end or object is known and we are to discover the way of achievement.

(b) Those in which some specified combination of conditions is proposed or known and we are to determine the results.

In the first we have fundamentally the problem of the inventor who is ever seeking new combinations through which some desired end may be realized, or again the problem of search for the causes of some specified or known condition or trouble. In the second we have the familiar problem of determining from known or proposed conditions, the unknown result. Both classes of problems involve the same fundamental items, the chief difference being in the point of view. In one it is relatively forward, in the other backward. In both it involves two primary mental operations—(a) the determination of the influences of various individual factors which may enter into the problem and (b) the mental combination of these various individual items or influences into one final result.

The highest degree of effectiveness will come then when all the factors which may possibly have any bearing on the problem are marshalled in order, passed in review, given each its due individual weight, and then combined with careful judgment into a final result. This discussion of mental processes is perhaps likely to seem academic and may be tedious. Some understanding of these matters is, however, of importance as an aid toward clearer and more effective

thought and study. Daily the engineer traverses operations of this character which through familiarity are carried forward almost instinctively and without conscious note of their exact character. Let me illustrate. In passing a given boiler note is taken of the fact that the water is low in the gauge glass and a moment's examination serves to show that no feed is coming through the check valve. This means a condition of trouble which must be instantly investigated, its causes determined and removed. Instinctively the engineer passes in review all possible causes of such a condition. The check valve may have been accidentally closed, it may have become jammed on its seat, the opening may have become clogged with waste or some other foreign substance, there may be a leak in the feed pipe, the feed pump may have stopped and if so, due to a whole series of causes which will be rapidly brought to mind if such is found to be the case. Then a rapid and systematic search will be started for the determination of which cause or what combination of causes is responsible for the given condition. One by one they will be eliminated until finally the explanation of the condition will be found and the basis for a judgment as to the best method of correction will be provided. Now it is clear that in any such problem efficiency of treatment requires three things in particular:

(1) The determination of all the factors.

(2) The assignment to each factor of its proper influence and importance.

(3) The development of a composite judgment based on the action and interaction of these various individual factors.

Again suppose we analyze the process by which the inventor proceeds in the search for some improvement or new development in the line of engineering equipment.

Suppose him to be in search, let us say, of a steam meter. He might perhaps analyze out the problem somewhat as follows:

Purpose in view, measurement of flow of steam in pounds per minute or per hour.

Weight of steam flowing along any pipe or through any orifice depends on three factors—area of stream of flow, velocity, density.

Steam as furnished from boiler may naturally vary in pressure and hence in density, also possibly in quality or degree of moisture.

The chief variable factors to be provided for are therefore variation in demand on the part of the consumer and variation in pressure and density on the part of the boiler.

These changes are then available to actuate some indicating or recording mechanism.

If for example the area is kept constant, means must be sought for causing the varying density and varying velocity to properly affect the registration of the apparatus.

If otherwise the velocity is kept constant then means must be sought to connect varying area and varying density with the registration of the apparatus.

And if finally density could be kept constant, then it would be sufficient to keep either velocity or area constant and to effect the registration by means of the one variable element.

The next step in the survey of the field would be the determination of all possible means by which change in velocity, or change in area or change in density could be made to affect the registration of an instrument. With such a survey completed the possibilities are in hand and it then becomes a matter of choice as to what combination of possible means and methods will be most effective for the purposes in view.

Such processes are typical of all search for the unknown, though we are not always careful to go about them in a thorough, systematic and exhaustive manner. Such processes always involve the analysis of a desired result into its various component factors, and the utmost care is necessary in order to be sure that the list is complete—that all the factors are included. Then comes a search for the various means of realizing mechanical embodiment for such factors, having in view the purpose desired. Here again the search must be exhaustive. We may safely assume that there are many ways of realizing any individual purpose or element of our problem, and it is very unlikely that the method which may first present itself will be the best of all. Further search should be made and a persistent effort must be directed toward the discovery of all practicable ways of realizing the particular purpose, and then a choice may be made.

All this is perhaps commonplace, but I am desirous of impressing, especially upon the younger members of the association, the high importance of bringing to every problem with which they may have to deal the highest qualities of mind backed by determined purpose, and of knowing no rest short of its thorough and systematic study along lines as indicated above.

Another powerful help in connection with the growth of the engineer in effective capacity may be found in the development of what may be called organizing centers, each in connection with some special class of topic in which keen interest is felt. The conditions for such development are first and foremost the existence of a definite and keen interest on the special topic in question, and then a direct and strong effort on the part of the will to refer everything in the way of facts, information and data relating to this topic, to this particular center of the mind for organization and safekeeping. This principle is so important that I wish to illustrate by a simple example.

Suppose we have two young engineers, A and B, with equal general educational advantages and training. Suppose that neither has yet been brought into very close contact with the special conditions which influence power plant economy. Suppose that A feels no special interest in such matters and has no special ambition to become posted with regard to the principles on which economy must depend; while B on the contrary feels the keenest interest in such matters, and has a determined purpose to thoroughly master the underlying principles. Such men from time to time will come into contact with many items of information relating to this general topic. To B they will have definite meaning, and will be eagerly absorbed by the memory. To A they will be next to meaningless and will make on the memory only the most fleeting impression. Thus the power plant may be visited

by some authority on the subject, and in conversation certain definite facts of importance and value may be mentioned. In the case of A they will enter the ears and cause the sensation of hearing, simply as a phrase or two of conversation. In the case of B they will be recognized instantly as facts or information corresponding to a well developed interest, and will be carefully stored away and grouped around such grasp of principle as may have been acquired regarding these matters.

In all this there is little of conscious effort. There is the existence of interest, attention, and a receptive, responsive condition regarding all such matters. Under such circumstances there is a natural almost unconscious absorption of such facts and items of information, and an equally unconscious reference of them to the organizing center which has begun to develop with reference to this particular topic. It will be found that after a time a very considerable body of information relating to this topic will have been acquired by B, with little of direct or conscious effort, and that such information will have gradually become organized, or crystallized, so to speak, about a center which may be called "interest in power plant economy."

In a similar manner by developing suitable interests, other lines of data and information may be acquired and organized in like manner. Thus such organizing centers may be developed with reference to many special topics of importance to the engineer, such as matters of cost and the general subject of the finance of power plants; matters relating to the organization and administration of power plants and other industrial undertakings; matters relating to the shop construction of the items of power plant equipment, etc., all of which will help to make him broader and more effective in the discharge of the daily duties of his calling.

Without such development of interest and of such centers of organization for groups of information and data, A may pass through the same environment, come into momentary contact with the same facts and opportunities, but with absolutely nothing of solid acquirement to show as a result.

I wish to speak now briefly of the source of errors made by engineers, and of the most effective means of overcoming, presumably the largest class. This is distinctly a practical question. We all know that we are subject to the making of errors. What are their sources and how may they be avoided.

We may conveniently note three classes of errors:

(1) Errors of ignorance.
(2) Errors of judgment.
(3) Errors due to lack of attention.

Errors of ignorance we all make. We are uncertain regarding some of the elements of our problem and we guess, or make some attempt at an estimate or determination, and an error is introduced. Such errors are not made unconsciously. We know of the uncertainty in our factors and realize that the final result must of necessity involve a similar margin of uncertainty. Much more dangerous are the errors which we make when we think we are right but are misled or mistaken. Here we may give full weight to our results, when in point of fact they involve the consequences of the error unconsciously made. There is no royal road for avoiding the errors due to ignorance. We can only strive to be sure of our facts if possible, and if not, to make the best possible estimate of the measure of uncertainty which may be introduced into the result by such uncertainty in the primary factors. If for example we obtain a final result which we estimate to involve a possible error of ten per cent in either direction, it is better perhaps than having no result at all, and better than having a result in which the error may be of unknown magnitude. Against unconscious errors of ignorance we can only exercise the keenest scrutiny of factors and datta, and endeavor to trace each item back to a thoroughly reliable source.

Against errors of judgment we have no general remedy. These again we all are liable to make. Our view of the various factors may be faulty or incomplete, our estimate of their relative influence or importance inaccurate, and so with the best of purposes we may arrive at faulty conclusions. Here again, painstaking care in the determination of the various factors and in the assignment of individual values, with careful weighing of each, separately and in combination, are the chief means available for leading us to correct conclusions from given initial data.

It is rather with reference to the third class of errors that I wish to speak, because such errors are made many times more frequently than those of the other two classes.

In this class we may include all errors of a numerical character, and in general all errors made in violation of our own knowledge when the mind is properly focused on the matter.

The mind has a valuable but at times a dangerous habit of going on working in an automotic or semi-automatic manner even when the attention is not keenly focused on the subject matter in hand. This is particularly the case when it is concerned with very familiar operations such as adding a column of figures, or doing a problem in multiplication or division. We all know how the attention can wander during such an operation. Entirely outside thoughts may float through the mind distracting the attention, or again keen interest in the subject in hand may tempt the mind to rush on ahead and consider other matters while almost like a machine the mental faculties are going through familiar arithmetical operations. All this would be well, if the automatic part of the operation could be depended on. But unfortunately it cannot. It is just when the mind is in such a state of divided attention that we say $6 \times 9 = 45$ or $9 + 8 = 18$ or $8 \times 9 = 72$ and 6 are 60 or other like errors. These are statements the error of which we instantly detect when the attention is focused on the matter, but which slip by unchallenged when the attention is directed elsewhere. Again in copying numbers from one place to another we may transpose or invert, as for example writing 756 instead of 657 or 9236 instead of 9326. Again we may take the price of something per pound instead of per foot, or we may use inches for feet or feet for inches. In short there is no end to the foolish and erroneous things which we may do

when the attention is thus relaxed or divided. Practically everything which we do correctly when the attention is properly focused, we may do incorrectly when such oversight is wanting. In the familiar phrase we know better but didn't think. The proper answer of our employers is that as long as we know better we should think, for that is what we're paid for.

There is no need of enlarging further regarding the character or frequency of such errors. We have all doubtless had keen personal experience of them. Now there is one and only one remedy. That is, never for one instant to relax the attention when engaged in operations of this character, and the more familiar the operations are, the more the tendency of the attention to wander and the greater the danger of running astray. It is not too much to say that it lies within the capacity of any one who chooses, to eliminate practically all errors due to such sources. It simply means undivided attention definitely focused directly on the matter in hand, and a resolute steadfast exclusion from the mind of all external beguiling topics. I speak of this matter with emphasis because it is of importance to us all in the every day duties of our calling. In some cases the frequency of such errors has seriously reduced the value of otherwise good engineers. I am convinced that any one with determination can break himself of the liability to errors of this character. It is simply a matter of a concentrated focus of attention. Purpose and will lie at the foundation, and to these we must now turn in closing.

This is a final point which needs no extended development. The conditions are demonstrated on every hand and by experience as old as the world's history. The progress of civilization has been marked times beyond number by failure or by half success on the part of those with good natural endowment and advantages, but who have lacked this one final element essential for success; while on the other hand the world's history has been made and the world's civilization has been achieved in very large measure by men and women of only modera'e initial endowment and often in spite of serious handicap of one form or another, but who have been fired with courage, purpose and determination.

The world's work today is being done and the new developments of the age are being opened up, not by natural born geniuses (if there are such) not primarily by those who have had the best advantages of birth and training, but rather by those who have become inspired with the largest measure of soul and purpose. In a very real sense we are coming to see that man is what he wills to be. Many elements must of necessity enter into the final make up of what we call success. I have endeavored to indicate some of them. Personality, morality, some element of what seems to be chance, these and others will also enter into the final complex result; but the greatest of all, certainly of those for which we as individuals have any measure of responsibility, is the element of purpose. And so as the closing thought, and one which I trust may be carried away and into the duties of everyday life, I would simply say that success awaits the grasp of him who wills to reach forth and take.

RECENT DEVELOPMENT OF THE PRODUCER GAS POWER PLANT IN THE UNITED STATES.[1]

BY ROBERT HEYWOOD FERNALD.

It was not until late in the nineteenth century that the gas engine came into common use, and although many types have been devised within the last twenty or thirty years it is only within eight or nine years that large gas engines have been constructed. This development started eleven or twelve years ago in Germany, Belgium and England, but marked progress has been limited to the last eight years.

For a long time the natural fuel of these internal-combustion engines was city gas, but this was too expensive except for engines of small capacity. It was seldom found economical to operate units of more than 75 horsepower with this fuel. Cheap gas was essential for the development of the gas engine, but the early attempts to produce cheap gas were somewhat discouraging, and for a time it seemed very unlikely that the gas engine would encroach to any extent on the field occupied by the steam engine. The theoretical possibilities of the internal-combustion engine operating with cheap fuel promised so much, however, that the practical difficulties were rapidly overcome, with the result that the internal-combustion engine has become a serious rival of the steam engine in many of its applications.

The development of the large gas engine within the last few years has been exceedingly rapid. It was only nine years ago that a 600- h. p. engine exhibited at the Paris exposition was regarded as a wonder, but today four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 h. p. can be found in nearly all up-to-date steel plants, and there are installations in this country containing several units rated at 5400 h. p. each.

The rapid advance of the large gas engine was made possible by improvements in the production of cheap gas directly from fuel by means of the gas producer. An early form of producer introduced in Europe, and now in general use both abroad and in the United States, is known as the suction producer, a name suggested by the fact that the engine develops its charge of gas in the producer by means of its own suction stroke. Although many producers of this type are now used, most of them are small, seldom exceeding 200 horsepower. A serious limitation to the utility of the suction producer has been the fact that, owing to the manner of generating the gas, no tarry fuels could be used, a restriction that prevented the use of bituminous coals, lignites, peats, and other like fuels. The fuels in most common use for producers of this type are charcoal, coke, and anthracite coal, although attempts are being made so to construct suction plants that they can be operated with bituminous or tarry coals.

To meet the demand for the concentration of power in large units, instead of operating a large number of separate installations of small power capacity, the pressure producer was devised. This producer develops its gas under a slight pressure due to the introduction of an air and steam blast, and the gas is stored

[1]Summarized from Bulletin 416, U. S. Geological Survey.

in a holder until it is required by the engine. As the gas may thus be stored before passing to the engine, and as its generation does not depend on the suction stroke of the engine, tar and other impurities may be removed from it by suitable devices, and the use of bituminous coal, lignite, and peat is thus permitted.

The pressure producer was closely followed in the course of development by the down-shaft producer, which fixes the tar as a permanent gas and therefore completely uses the volatile hydrocarbons in bituminous coal, lignite and peat.

A few scattered producer-gas plants were installed for power purposes in the United States before 1900, but the application of this type of power in any general sense has been developed since that date. During the first few years of this period of development antharcite coal, coke and charcoal were used almost exclusively, although occasionally pressure and down-draft plants ventured to use a well-tried bituminous coal known to be especially free from sulphur and caking difficulties and low in both ash and tar making compounds. The rapid development of the anthracite plant was to be expected, but it remained for the United States Geological Survey in its testing plants at St. Louis and Norfolk to demonstrate the possibility of using in such plants practically all grades of fuel of any commercial value, without reference to the amount of sulphur or tarry matter which they contain.

In considering the relation between the economic results of plants of the two types under discussion, namely, steam and producer-gas, the fact should be remembered that today, in the ordinary manufacturing plant operated by steam power, less than 5 per cent of the total energy in the fuel consumed is available for useful work at the machine.

In that connection it is of interest and value to glance at the possibilities of the best designed and most skilfully operated commercial plant now in use. The data concerning the steam plant selected for this determination are derived from a table prepared by Mr. Stott, superintendent of motive power, Interborough Rapid Transit Company, New York City, which, as Mr. Stott says shows "the losses found in a year's operation of what is probably one of the most efficient plants in existence today, and, therefore, typical of the present state of the art."

Average losses in steam plant of the Interborough Company in converting 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss by friction	138	1.1
Loss in exhaust	7,513	60.1
Loss in pipes and auxiliaries	275	2.2
Loss in boiler	1,000	8.0
Loss in stack	1,987	15.9
Loss in ashes	300	2.4
Total losses	11,213	89.7
Energy utilized	1,287	10.3
	12,500	100.0

Mr. Stott further presents a table showing the thermal efficiency of producer-gas plants, concerning which he says:

The following heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

Average losses in a producer-gas plant in the conversion of 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss in gas producer and auxiliaries	2,500	20.0
Loss in cooling water in jackets	2,375	19.0
Loss in exhaust gases	3,750	30.0
Loss in engine friction	813	6.5
Loss in electric generator	62	.5
Total losses	9,500	76.0
Converted into electric energy	3,000	24.0
	12,500	100.00

The thermal efficiency of such plants, as given by different writers, runs as high as 33, 36 and 38.5 per cent, and for some plants figures as extravagant as "above 40" are boldly published. Although the present aim has been to give figures for a producer-gas plant that may compare favorably with those of the steam plant of the Interborough Company, an effort has been made to keep well within obtainable efficiencies. Attention is also directed to the fact that the producer-gas plant considered should be large enough to compare favorably with the steam plant. This precludes comparisons with suction plants, which are relatively small but give higher proportional efficiencies than the larger pressure and down-draft plants, for these require more or less auxiliary apparatus.

Mr. Stott seems ready to accept a thermal efficiency of 24 per cent for the best producer-gas plants for comparison with 10.3 per cent efficiency for his steam plant, but a careful study of the problem has led to a more conservative estimate for the producer-gas plant, namely, 21.5 per cent.

The tables just given show the comparative efficiencies reached in plants of the best type, both steam and producer-gas, but these are seldom realized in common practice. The results obtained in the government plant at St. Louis are probably more nearly representative of the ordinary type of apparatus. These results are as follows:

Relative economics of steam and gas power plants at St. Louis in the conversion of 1 pound of coal containing 12,500 British thermal units into electricity.

	Steam power.		Gas power.	
	British thermal units.	Per cent.	British thermal units.	Per cent.
Losses in exhaust, friction, etc.	11,892	95.14	10,812	86.5
Converted into electric energy	608	4.86	1.688	13.5
	12,500	100.00	12,500	100.0

Especial attention is called to the fact that several low-grade coals and lignites that have proved of little value or even worthless under the steam boiler have given excellent results in the gas producer.

The ratios of the total fuel per brake-horsepower hour required by the steam plant and producer-gas plant, under full load, not counting stand-by losses, are presented below as derived from 75 coals, 6 lignites, and 1 peat (Florida).

Ratios of Fuel Used in Steam and Gas Plants.

Average ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer	2.7

Maximum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer 3.7

Minimum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer 1.8

Average ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer..... 2.7

Maximum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer..... 2.9

Minimum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer..... 2.2

Average ratio, peat as fired per brake-horsepower hour under boiler to peat as fired per brake-horsepower hour in producer 2.3

The figures for the producer-gas tests include not only the coal consumed in the gas producer, but also the coal used in the auxiliary boiler for generating the steam necessary for the pressure blast—that is, the figures given include the total coal required by the gas-producer plant.

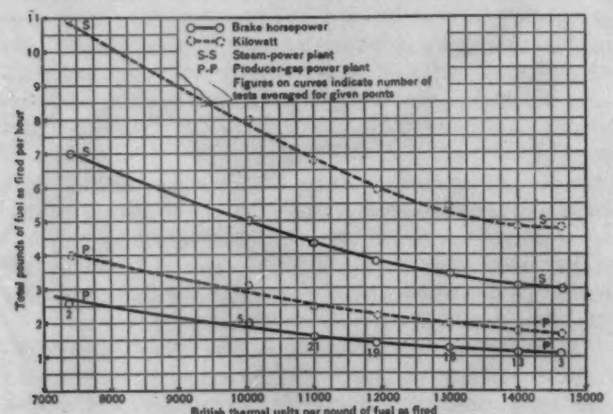


Fig. 1.—Comparative Service of Coals and Lignites in Producer and Steam Boiler Plants.

The curves in Fig. 1 show graphically the great economy secured from the 75 bituminous coals and 6 lignites when used in the gas producer instead of under the steam boiler. The results of the tests are officially reported on the basis of switchboard horsepower, but in order that they may be of more practical value they are given here on the basis of brake horsepower and kilowatts—the efficiency of electric generator and belt in each plant being assumed as 85 per cent.

In the above comparisons between the steam and producer-gas plants no consideration has been made of stand-by losses. The result for each plant has been derived from experiments made during continuous operation for a given period. Data on stand-by losses for plants operated during a portion of each 24-hour day are not at present obtainable at the fuel-testing plant. Very few results of experiments relating to this point have been published, and opinions regarding the amount of fuel required for holding fires over night or during idle periods in both boiler and producer plants seem to differ widely.

In considering the possible increase in efficiency of the steam tests with a compound engine, as compared with the simple engine used, the fact should not be overlooked that a corresponding increase in the efficiency of the producer-gas tests may be brought about under corresponding favorable conditions. Not only is the producer passing through a transitional period, but the gas engine must still be regarded in the same light. In the larger sizes the vertical single-acting engine is being replaced by the horizontal double-acting engine. Other changes and improvements are constantly being made which tend to increase the efficiency of the gas engine, as compounding and tripling the expansions have already increased the efficiency of the steam engine.

As has already been stated, the gas engine used in the tests here reported is of a type that is rapidly becoming obsolete for this size, namely, the vertical, three-cylinder, single-acting.

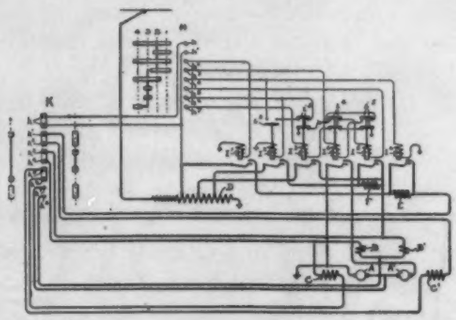
A brief consideration of these points will lead at once to the conclusions that a comparison of the producer-gas plant and steam plant used in these tests is very favorable to the former, and that any increase in efficiency in the steam tests that might result from using a compound engine can be offset by the introduction of a gas engine of more modern type and a producer plant designed to handle the special kinds of fuel used.

It should be noted that many fuels which give poor results under steam boilers have been used with great ease and efficiency in the gas producer, which thus makes it possible to utilize low-grade coals and lignites that have heretofore been regarded as practically useless. Several of the poorest grades of bituminous coals have shown remarkable efficiency in the gas producer, and lignites and peat have been used in it with great facility, thus opening the way to the introduction of cheap power into large districts that have thus far been commercially unimportant owing to lack of industrial opportunities. Experiments with "bone," a refuse product in bituminous-coal mining, have given excellent results, showing an efficiency in the producer equal to that reached by good steam coal under boilers. Recent investigations with other low-grade fuels, such as mine roof slabs, culm, and washery refuse, have also demonstrated the possibility of using such material to advantage in the producer under proper commercial conditions.

It has not been the aim of the testing plant to determine the lowest possible amounts of coal that could produce a given amount of power or to determine the highest possible efficiency of the particular producer plant installed. By an act of Congress, the work of the plant was restricted to the determination of the possibilities of utilizing bituminous coals, lignites, and other fuels for the production of power. In spite of the fact that no series of runs has been made on any one coal for determining the best possible results obtainable, it is nevertheless gratifying to report that official records show that as small an amount of dry coal as 0.95 pound per hour has been burned in the producer per electrical horsepower developed at the switchboard; or 0.80 pound of dry coal per hour has been burned in the producer per brake horsepower per hour, on the basis of an efficiency of 85 per cent for generator and belt.

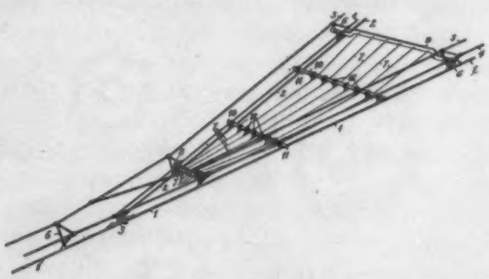
PATENTS

946,751. Alternating-Current-Motor Control. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. In combination with a pair of alternating-current motors of the commutator type having their armatures normally connected in series, a control system arranged to short-circuit said armatures for low-speed operation and to open the



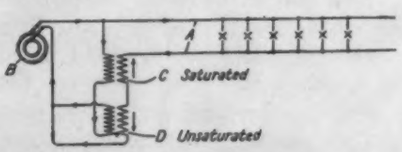
short-circuit and impress a voltage on said armatures for high-speed operation, a cut-out switch arranged to cut either of said motors out of circuit, and means controlled by the cut-out switch for rendering the control system inoperative to establish the high-speed connections when one motor is cut out.

946,590. Electric-Trolley-Line Construction. Theodore Varney, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. In an electric line construction, the



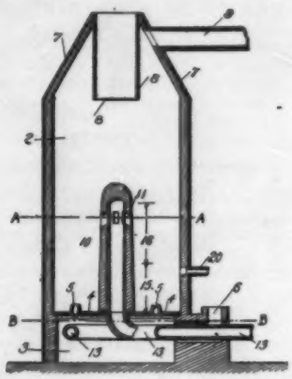
combination with trolley conductors forming a V-shaped junction, and supporting means therefor, of a plurality of diverging guard wires located between the trolley conductors, supporting cross-bars clamped to the ends of the guard wires and to certain trolley conductor supports, and intermediate cross pieces clamped to the guard wires and provided with trolley hangers.

946,829. Compounding Alternating-Current Circuits. William Stanley, Great Barrington, Mass., assignor to General Electric Company. In combination with a load circuit and a



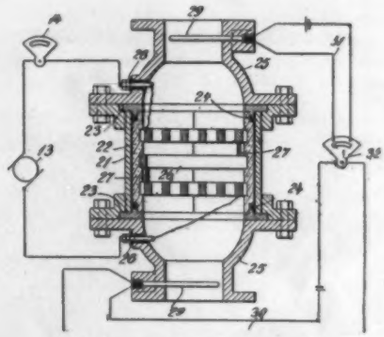
source of alternating current therefor, means for compounding the voltage supplied to the circuit under varying load comprising two transformers having their primaries connected in series with each other and in shunt to the source and their secondaries connected in series with each other and with the load, the cores of the two transformers being so proportioned that one is saturated and the other unsaturated.

946,820. Gas-Producer. Thomas Clouston, Vancouver, British Columbia, Canada. In a gas producer, the combination with a generating chamber having a partition grate across the bottom and a charging inlet projected within the top, of means for delivering air from the space beneath the par-



tition, grate through twyers upwardly projecting from the partition, means for collecting gas generated from about the mid-height of the generating chamber and for delivering the same through a passage exposed to the heat of the incandescent fuel in the lower part of the same chamber, and means for delivering the hot gas so collected through a pipe exposed to the incoming air in the space beneath the partition grate.

946,886. Method of and Apparatus for Determining Rate of Flow of Steam and Other Gases and Vapors. Carl C. Thomas, Madison, Wis. The method of determining the rate of flow of wet steam and like vapors, which comprises passing a moving current of such vapor in heating proximity to electrical resistance means, passing through such resistance



means electric current sufficient to generate enough heat to superheat the vapor and so convert it into gas, and also passing through such resistance means a further known amount of current and determining the rise of temperature produced in the gas, during a unit of time, by the passing of such additional amount of current.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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CONTENTS

Power Development of the Clackamas 93

More Land Withdrawals 94

Opportunities, Responsibilities and Training Necessary for Success in the Engineering Field 95
By W. F. Durand.

Recent Developments of the Producer Gas Power Plant in the United States 102
By R. H. Fernald.

Patents 105
Alternating Current Motor Control.
Electric Trolley Line Construction.
Compounding Alternating Current Circuits.
Gas Producer.
Determination of Rate of Flow of Steam.

Editorial 106
Pinchot-Ballinger.
Producer-Gas Power.

Personals 107

Seattle Section, A. I. E. E. 107

Los Angeles Electrical Men's Club 108

Trade Notes 108

News of the Stationary Engineers 109
Practical Mechanics, Paper No. 5.

Industrial 110
Gas-Electric Motor Cars.
Klein's Metal Pole Supporters.
A. C. Motor-Operated Gate Valve.

New Catalogues 111

News Notes 112

Pinchot-Ballinger

The attitude of the "Journal" towards Mr. Gifford Pinchot, has been always one of friendly fairness. We have admired the man, though forced to deplore, at times, an uncompromising zealotry that seemed to possess him. That gentleman was so impressed with our fairness of statement in our discussion of the hydroelectric problem that he quoted in "Conservation" one of our editorials in full, declaring it to be "As fair and logical a presentment of the case as we recall having seen in a long while."

With this introduction the casual reader will not misunderstand what follows.

It is deplorable that a man who could have been of such vast service to his country as Mr. Pinchot might have been, should have disqualified himself from further usefulness to the nation as a public officer, through his own deliberate act. An insubordinate subordinate is intolerable in any employment. Mr. Pinchot understands this as well as anyone.

Personally we believe Mr. Pinchot invited his own dismissal—nay, more than that, he demanded it. There was nothing left for the President to do. For a like offense Mr. Roosevelt would have dismissed Mr. Pinchot quicker than did Mr. Taft, but with more pyrotechnics. Harsh criticism of Mr. Taft for his action is unjustifiable. If the offending Pinchot could not possibly be replaced, such criticism might be natural, even though unfair.

Of course it is going too far to say of Mr. Pinchot that he is the only man in America honest enough or wise enough to supervise the great work of conservation. There are others who will do as well and who, lacking certain personal peculiarities, may do better than he. The same may also be said with equal truth of Mr. Ballinger.

Mr. Ballinger has not yet placed himself in a position justifying his dismissal, unless we prejudge his case. But this much seems quite certain. He ought to resign. He ought to relieve the President and the entire country by withdrawing unequivocally, whether he be under fire or nor under fire. As a friend, he is not an administration asset—he is a liability.

Believing that Mr. Pinchot, rather than resign, deliberately invited, if not planned, his own dismissal; and believing too that he is a fair minded gentleman, it is somewhat inexplicable that he should permit the President to be harshly criticised for the doing of a thing he had rendered compulsory. Some men in Mr. Pinchot's place, no matter what their personal feelings might be, would issue a statement that would relieve the President of unjust criticism, of unwise friends. And we must confess to liking such a man.

If Mr. Pinchot, for some cause or other, had decided to get out of office, and if he then carefully planned not to resign but to commit some overt act that would inevitably bring about his dismissal, so as to injure the administration, and bring upon it unjust

criticism, and if this was his deliberate purpose, as it seems to have been, then we must amend our views of Mr. Pinchot's personality.

Producer Gas Power

Until ten years ago the theoretical efficiency of producer-gas power was the will-of-the-wisp that lured many a dollar from the pocket of the power plant owner. Made chary by initial impressions, which are proverbably lasting, he is now slow to be convinced that recent improvements in both the producer and the engine have given a power plant that is at once efficient and reliable. The case is in many respects similar to that of the electric vehicle, whose early defects have prejudiced people against its present perfections.

Producer-gas is the result of the incomplete combustion of coal, its active constituents being carbon monoxide and hydrogen, diluted with a large amount of inert nitrogen. Mixed with air and exploded in the cylinder of a gas engine it drives the piston, thus effectively utilizing from two to three times as much of the energy available in the coal as does the steam engine.

Its great success has been with anthracite coal, although experiments made by the Fuel Testing Department of the United States Geological Survey show that bituminous coal, bone coal, lignite and peat can be successfully utilized. More than half of the total producer-gas horsepower in this country is developed from bituminous coal and lignite. For this purpose the suction producer has not proved uniformly satisfactory, the pressure type being seemingly better adapted for soft coals. The producer is yet in a state of transition; the apparatus has not become standardized as has steam equipment; few engineers understand how to handle a plant to the best advantage; its initial cost is high. These disadvantages, however, are but transitory and are already more than compensated by the low cost of its power. There can be little doubt but that in time producer-gas plants will be centralized in the coal mines as have been hydroelectric plants at the water power sites, and the energy distributed either by means of high pressure gas mains or long distance electrical transmission.

Last month the members of the California No. 3, National Association of Stationary Engineers, were favored with one of those whole-souled talks of advice that have endeared Professor Durand to all of his students. Through the courtesy of the Association we are enabled to print this address elsewhere, and would commend its perusal to all of our readers. His talk is concerned primarily with the mental equipment that brings success. Being intended for the steam engineer it employs mechanical analogies with which he is familiar. Emphasis is laid upon the fact that a man's "thinkery" is of even greater importance than his memory.

PERSONALS.

John Nixon, lately with the Buckley Electrical Company, is now in charge of the lighting plant at LaConner, Washington.

E. E. Burgess, manager of the Davenport Light & Power Company, of Davenport, Cal., was a San Francisco visitor during the week.

C. P. Platt, consulting engineer of the Home Telephone Company, returned to San Francisco last week after a business trip to New York.

Charles M. Hall, vice-president of the Aluminum Company of America, left Niagara Falls, accompanied by Dr. W. H. Hodge, and is visiting the Pacific Coast for his health.

R. A. Balzari, who has been for several years with the San Francisco office of the Westinghouse Electric & Manufacturing Company, is now covering Northern California as sales engineer.

A. D. Schindler, general manager of the Northern Electric Railway Company, whose leg was broken in an elevator accident last week, is resting easily at the Hahnemann Hospital in San Francisco.

Leon M. Hall and D. C. Demarest, together with Sidney M. Stone, A. C. Sprout, W. G. Morrow and W. C. Wallace, have opened offices in the Kohl Building, San Francisco, as Hall, Demarest & Co., engineers, making a specialty of mines, mills and power plants.

Jack Furness, who has been chief engineer for the Palace Hotel Company of San Francisco for the past thirty-seven years, has resigned. He had charge of both the Fairmont and Palace power plants. Assistant Engineer Trimble has gone from the Humboldt Bank Building plant to the Palace as acting chief.

H. A. Hageman has resigned as assistant superintendent of mechanical operations at the plants of the Niagara Falls Power Company and the Canadian Niagara Power Company, Niagara Falls, to accept a position with Stone-Webster Engineering Corporation to design and construct a power plant near Seattle.

W. H. Leffingwell, the engineer in charge of the Mono Power Company's hydroelectric construction work on the Owens River has arrived from Bishop, Nev., to confer with his principals in San Francisco. More than $150,000 has already been expended on the transmission project which will supply Tonopah and Goldfield with electric power.

Eeric H. A. Nordin, a hydraulic engineer who has been connected with the construction of several power plants for the Guggenheim interests in the Sacramento Valley region, has arrived from Marysville. He is en route to New York and will sail thence to Barranguilla, Colombia, where he is engaged to spend a year and a half in installing a power plant for the Guggenheims.

C. W. Stone, assistant engineer of the lighting department, and D. R. Bullen, manager of the supply department of the General Electric Company, Schenectady, are expected to arrive in San Francisco the second week in February to attend the annual agents' meeting for this district at the San Francisco office. They will also attend a similar meeting in Portland for the benefit of the agents in the Pacific Northwest.

SEATTLE SECTION A. I. E. E.

A. A. Miller has been elected chairman and W. S. Hoskins secretary and treasurer of the Seattle Section A. I. E. E. The selection of the executive committee has been postponed until a later date. A. A. Miller of the Westinghouse Company gave a lecture on Single Phase Railway Equipment, illustrated with stereopticon views. At the February meeting Renier Beeuwkes, assistant to Dr. Cary T. Hutchinson, will give a paper on the Cascade Tunnel Equipment.

ELECTRICAL MEN'S LUNCH CLUB OF LOS ANGELES.

At the regular monthly meeting of the Electrical Men's Lunch Club of Los Angeles, held January 13th, Mr. B. F. Pierson, general superintendent of the Southern California Edison Company, gave the members a very interesting talk on the development of the Edison Company in and around Los Angeles. Beginning about a dozen years ago with a second-hand boiler, engine and generator and coming down to the present time, touching lightly on each stage of development. Mr. Pierson stated the company had in prospect the building of another power plant on the Kern River, contemplating a 160,000 volt line. This point is particularly interesting, when considering the fact that less than 15 years ago certain prominent engineers insisted that even a 15,000 volt transmission line was impossible and had to be demonstrated in this particular locality before the practicability of such a line was possible. Mr. Pierson's remarks were thoroughly appreciated by the 64 members present and an earnest request made for an early return address. Mr. A. W. Ballard, local manager of the General Electric Company was elected chairman and Mr. Walton of the Southern California Edison Company vice-chairman, and Mr. R. B. Clapp of the Westinghouse Electric Company secretary for the ensuing year.

TRADE NOTES.

On February 1st the National Conduit & Cable Company will open offices in Los Angeles, with Mr. Walter Fagan in charge. Mr. Fagan has been purchasing agent for the Pacific States Electric Co.

The Lindsley Wright Company of Portland report a marked increase in the demand for long poles. Deliveries between January 1st and the 10th amounted to 2,500 poles. The supply is rather limited.

The Wire & Cable Company of Montreal announce that the Northern Electric and Manufacturing Company, Limited, 918 Pender street Vancouver, have been appointed sales agents for the Province of British Columbia.

The proposed consolidation of the Kellogg Switchboard & Supply Company with the Dean Electric Company, under the name of the Kellogg-Dean Electric Company, has not materialized, and all steps in that direction have ceased.

The Valley Power Company of Minneapolis, Minn., have ordered from the Westinghouse Company at Seattle a 550 k. w. generator, 30 k. w. exciter, three 200 k. w. transformers, switchboard, etc., for their plant at Cashmere, Washington.

The Portland Wood Pipe Company just closed a contract with the Post Falls Irrigation & Land Company of Coeur d'Alene, Idaho, to build five miles of continuous stave pipe line from Hayden Lake to the company's reservoir near Monoghan, Idaho.

Barnes Lindsley Company, the largest manufacturers of cross-arms on the Coast, have made several large shipments recently, and report the outlook for the coming year as being very favorable. They are preparing a large reserve stock in anticipation of the season's heavy demand.

The Pittsburg Testing Laboratory, inspecting and testing engineers, Pittsburg, are erecting a large 5-story fireproof office and laboratory building to house their rapidly growing business. They are represented on the Pacific Coast by Smith, Emery & Co., inspecting and testing engineers.

Kilbourne & Clark Company of Seattle have been awarded the contract of installing the electric motor drain pumping plant for the Columbia River Orchards Company at Priest Rapids. The plant will consist of four 300 h. p. units with a combined capacity of 40,000 g. p. m. against a head of 83 ft. The machinery will be housed in a waterproof concrete structure which will be submerged during high water periods.

Kilbourne & Clark Co., electrical engineers of Seattle, Washington, have established a branch office and warehouse in Portland, with a large stock of electrical machinery, including Crocker-Wheeler apparatus and Wagner Mfg. Company's machinery. R. M. Vaughan is district manager with offices in the Couch Building.

H. V. Wilkenson and H. H. Thedinga formerly with the Canadian Westinghouse Company at Winnepeg and later with the Seattle Department of Public Utilities have formed a partnership as general consulting electrical and illuminating engineers with offices in the Central Building, Seattle, Washington.

Kilbourne & Clark Company of Seattle manufacture an inverted rotary converter for wireless telegraphy on shipboard. The Ceres, equipped with one of these converters, recently established a record for long distance, 4620 miles. The United States Government will investigate this converter with a view to adopting it for the Navy. It is remarkable for its efficiency and economy, 5 k. w. is the largest size required for any wireless equipment.

The General Electric Company through their San Francisco office has sold a 475 h. p. horizontal Curtis turbine direct connected to a Byron Jackson centrifugal pump for use on a plantation near Honolulu. They have also sold to the Key Route electric railway system of Oakland an additional 2700 k. w. railway generator set to be direct connected to Hamilton & Corliss engine furnished by Chas. C. Moore & Co., the present capacity of the station being 4700 k. w. in four units, two 1600 k. w., one 750 k. w. and one 650 k. w.

The Inland Empire Railway Company of Spokane have placed an order with the Westinghouse Electric Company of Seattle for a complete equipment of the second half of their power plant at Nine Mile, including two 3000 k. w. generators, two 3000 k. w. three-phase 6600-volt transformers, high tension switches apparatus, etc. The installation will be complete by June 1st. For their substation in Spokane they have placed with the Westinghouse Company an order for two 1500 k. w. synchronous motor generator sets, four 2000 k. w. 66,000 volt single phase transformers, switchboard and equipment. They have also ordered ten quadruple city car equipments.

Sanderson & Porter through their San Francisco office report that they have closed a contract with Milliken Bros. of New York for special steel tower extensions aggregating 300 tons in weight for the transmission line of the Sierra & San Francisco Power Co. These are to be installed at crossings at Alviso, San Joaquin river and various sloughs on their line. There are 27 of these extensions, some of which are 87½ ft. high and on which the standard 50 ft. towers, supplied by the Aeromotor Company will be erected, giving a total height of 132 ft.; the remainder will be 62½ ft. high, giving a total height of 112½ ft. The standard spans are maintained so that the crossings will not exceed 750 ft. except at the Alviso crossing.

The Kellogg Switchboard & Supply Company's reputation for quick delivery of the very highest class work on rush switchboard and telephone orders is well known. Recently two rush orders for switchboards replacing fire losses at Lamar, Mo., and Bath, Michigan, were completed and delivered on record time. Quick deliveries by this company, as their customers will appreciate, do not mean carelessly put together apparatus, but the standard built Kellogg exchange. At the close of the year two more telegraph orders for switchboards replacing boards destroyed by fire were received. One for Dardanelle, Arkansas, for one 300 line, two position magneto switchboard with 200 lines equipped—two operators' sets and 20 cord circuits. The other from the Hollandale Telephone Company, Hollandale, Wisconsin for one 100-line magneto switchboard.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec., David Thomas, 914 O'Farrell St.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS, PAPER NO. 5.

Having covered in the preceding papers the elementary analysis of uniplanar motion, we will now proceed to the study of the various forms of machines for transmitting motion. It is to be remembered that we have in mind at present only the transmission of pure rotation. Referring to the table in paper No. 1, we shall first consider the fourth method of transmission—that by link-work.

We are taking up the link-work transmission, or transmission through a rigid intermediate member first, because it is simpler in application than are the other forms to be considered, and because it is the most efficient of all forms of transmission. This high efficiency is possible because the resistance due to friction is only that of small pins in well lubricated bearing holes, and there are usually fairly long arms with which to turn these pins. Furthermore the pins never make but one revolution for each turn or cycle of the machine and often but a fraction of a complete revolution; while in the corresponding movement of a cam motion, for example, the roller makes from six to twelve turns. Link-work is, therefore, much more durable and positive than other forms of mechanism. The possible variations in the application of link-work are, however, few, their movements being among the most arbitrary laws of motion and for this reason it must in many cases be abandoned where it would otherwise be preferable. It is usually best therefore to consider a proposed link-work movement complete, and if found unsuitable attempt another, rather than to assume the law of motion and endeavor to make the link-work conform to such law.

In applying a rigid intermediate members to transmit rotation from one body to another, the possible cases are:

1—*Axes of rotation parallel*, either in the same straight line or otherwise.

2—*Axes of rotation intersecting*, without meeting.

3—*Axes of rotation crossing.*

We shall consider these cases in the order named.

Axes of rotation parallel—Where the axes of the two rotating parts are in the same straight line, there is necessary merely an axle or shaft to rigidly connect the parts. This, of course, at once fixes not only the condition that both parts shall turn with the same angular velocity, but it requires further that the angular velocity at all points of any revolution be the same for both members.

The important considerations in the particular case of axes in line is rather one of journal bearing and shaft design. As it is not the purpose of these papers to go into machine design the reader is left to consult some good work on the subject.

Taking now, the more general case of axes, parallel and not in the same line, we come to the most useful and familiar form of link-work.

The well known locomotive side-rod is a good example. This application necessitates that both pins of attachment be located at the same distance from their respective centers of rotation, otherwise complete revolution is not possible. It is to be noticed also that when the two pins are in line with the two axes of rotation the motion is not constrained. This condition is provided by the addition of a second rod and set of pins or cranks placed at some angle, other than zero or 180 degrees with the first pair of pins. It is usual to place this second set of pins at an angle of 90 degrees with the first set, as the strains on the entire mechanism are thereby reduced. Where the parallel axes are not far out of line a useful form of coupling is that known as the Oldham coupling. Two dotted disks at the end of each shaft, are connected by an intermediate disk provided with raised prismatic guides, which fit the respective stops. These guides run diametrically across each face of the disk and are best placed at right angles to each other. This form of transmission is much less efficient than the intermediate rod and pins would be. It will usually be found, too, that, where the axes are nearly enough aligned to permit of the use of this form of coupling it will be possible to exactly line them up and use a direct coupling.

A certain form of the universal joint is applicable to the transmission of rotation between parallel shafts, but as this is a special case of the general application of the universal joint, it will be described after the general case is discussed under intersecting axes.

TRADE NOTES.

The Yale Laundry at Portland will increase its power plant, adding an engine and generator set.

The Whatcom Railway & Light Company have ordered 2000 k. w. Curtis turbine generator and 3500 h. p. Pelton water wheel to be installed at Bellingham, Wash.

The Standard Lumber Company at Deer Park, Washington, have equipped their mill with 500 h. p. Curtis turbine generator set and individual motor drive for each machine.

The British Columbia Electric Railway Company has placed an order with Allis-Chalmers Company for two 2000 k. w., 1800 r. p. m., 60 cycle, 3-phase condensing steam turbo generator units. These will be used in connection with extension of the service.

The Weed Lumber Company of Weed, California, is arranging to drive much of the machinery it uses with motors and has ordered a 750 k. w., 3600 r. p. m., 60 cycle, 3-phase, 600 volt condensing steam turbine unit from Allis-Chalmers Company to supply the necessary power.

The new power plant being installed at St. Vincent's Hospital of Portland, Oregon, includes a boiler battery of 210 h. p., two American Ball engines, one 100 h. p. and one 75 h. p.; two Westinghouse 3-wire generators, 50 and 75 k. w. The power house is of brick and has a concrete stack 155 ft. high and 54 in. in diameter. The plant is equipped with a Webster vacuum system, Johnson heat regulating system, electric elevators, modern laundry plant, and cold storage units on every floor.

INDUSTRIAL

GAS-ELECTRIC MOTOR CARS.

A brief description of the gas-electric motor cars recently purchased by the Southern Railway Company from the General Electric Company, and now under construction, should prove of interest to the many steam railroads which operate similar service. As shown in the outline views these cars have been designed with special reference to traffic conditions in the South. The car is divided by a center entrance. The seating capacity forward of this entrance is 14, and to the rear is 38, making a total seating capacity of 52 passengers. A rear entrance is also provided, thus completely dividing the forward and rear passenger compartments.

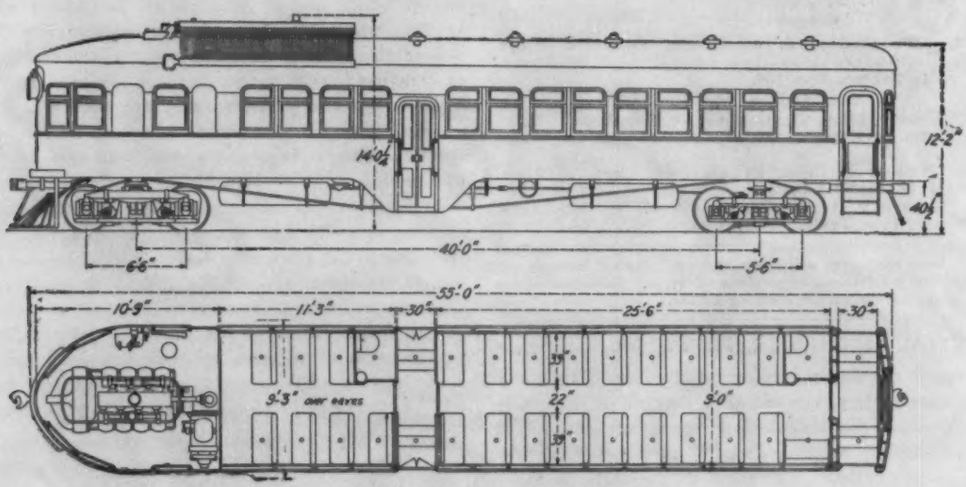
The car body is 55 ft. long over bumpers, and of this space the engine compartment will take up 10 ft. 9 in., leaving the balance for passengers and platform. The car will be constructed of steel frame work and sheathed with steel plates, the interior trim being of mahogany.

gas engine is also direct connected to a generator for lighting the car.

Combined straight and automatic air brakes will be furnished, together with the usual auxiliary apparatus and in addition to these brakes an auxiliary ratchet and hand brake is part of the equipment for emergency use. A radiator is placed on the roof of the car which provides an efficient means of cooling the engine on the thermo-siphon principle. During the cold weather, hot water from the engine circulating system will be by-passed through the passenger compartments.

Although these cars can be geared for a speed of about 60 miles an hour on tangent level track, such speeds are not usually required on branch line service and the Southern Railway cars will be geared for a somewhat lower maximum speed.

The ease of control and smoothness of acceleration are prominent features of this type of equipment and are secured



Outline View of Gas-Electric Motor Car.

The truck under the engine compartment will have a wheel base of 6 ft. 6 in. and will be equipped with M. C. B. 33 in. steel wheels. On each axle of this truck will be mounted standard 100 h. p. 600 volt box frame, commutating pole, railway motor, type GE-205, thus giving the car a motor capacity of 200 h. p. The rear truck will have a wheel base of 5 ft. 6 in.

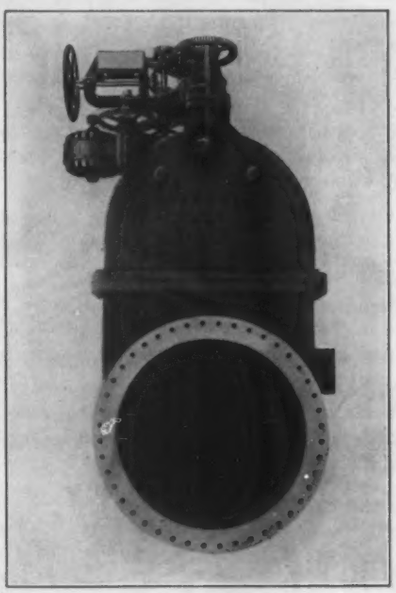
In the engine compartment there will be a direct driven gas engine generator set, the engine being of the 8-cylinder "V" type, each cylinder 8 in. in diameter by 8 in. stroke. Direct coupled to this engine will be an 8-pole 600 volt generator provided with commutating poles. This set will be mounted on a cast iron base, and all parts will be above the floor line and readily accessible. Current from the generator will be supplied to the motors through a controller, the function of which is to place the motors progressively in series and parallel and to vary the resistance in the shunt field of the generator by means of numerous steps, thereby varying the impressed voltage on the motors. The engine ignition is furnished by a low tension magneto and magnetic spark plugs. The carburetor is of the over-flow type and hot water jacketed. Compressed air is used for starting the engine, this being supplied to the several cylinders in succession through a distributing valve. Compressed air is supplied from a pump direct driven by the main crank shaft. A small auxiliary gas engine will drive an auxiliary pump to supply compressed air to the main reservoirs when necessary. This solely by reason of the gas-electric drive principle which it embodies. As there is no mechanical transmission between the engine and the axle, the speed of the engine is not a function of the speed of the car, consequently, the gas engine may be operated so as to give its maximum output irrespective of the speed of the car—a characteristic which is of great value in case of emergency or heavy work. It has been found that the electrical equipment, consisting of the generator, controller and motors and which takes the place of the gears, chains, sprockets, clutches and other mechanical means of transmitting the power of the gas engine to the axle, is subject to very little maintenance expense and the efficiency of this electric drive is high. The feature, perhaps, which will most strongly appeal to railway men is the simplicity of this control and the ease and certainty with which it can be handled by an ordinary unskilled operator.

KLEIN'S METAL POLE SUPPORTERS

Have the advantage of lightness and strength, smaller diameter of the uprights, which makes them more convenient to handle, and allowing the follow-up-man to work with more agility than with the wooden pattern. Furthermore, being of metal, they are not warped and twisted and weakened by exposure to the weather, and consequently are indestructible. The flange at the foot prevents the support from sinking into soft ground. Made in the customary sizes, 6-foot, 7-foot and 8-foot.

A LARGE ALTERNATING CURRENT MOTOR OPERATED GATE VALVE.

The large alternating current motor operated gate valve shown in the accompanying illustration is installed at the plant of the Pressed Steel Car Company, McKees Rocks, Pa., where it is inserted in the exhaust line from a 1000 k. w. Westinghouse low-pressure turbo-generator to the condenser. The valve closes upon a clear opening 48 inches in diameter, and is operated by a 3-horsepower, three-phase, 60-cycle, 550-volt Westinghouse type "CCL" induction motor. The motor speed of 1120 r. p. m. is reduced through suitable gearing to the speed of the main operating thread, proper for closing the valve safely and quickly. A hand wheel for hand closing is also provided. A worm gear on one of the intermediate shafts operates a limit switch mechanism, which automatically controls the movement of the gate by stopping the motor at a certain point in the gate travel either way.



A. C. Motor Operated Gate Valve.

To open or close the valve, it is thus necessary only to throw the operating switch into the corresponding position, starting the motor which continues to run until it is automatically cut off when the end of the valve travel is reached. The valve is thus operated with the absolute minimum of effort or trouble, and can be closed or opened at the predetermined safe operating speed as easily as switching on an electric light. The limit switch which accomplishes this automatic control is enclosed in the box shown at the right of the valve gear. The operator's switch, by which the valve is opened or closed, may be located in any convenient position about the building or plant.

The assembly of the motor and gearing in the instance shown was a special construction made necessary in clearing neighboring pipes and walls. Applications of alternating current motors for control services of this kind are yet in the classification of novelties, but the excellent performance of this apparatus has demonstrated that the induction motor is rapidly coming to occupy the wide field in which the direct current motor has already proven so pre-eminently the ideal motive power. The 48-inch gate valve illustrated was designed and built by the Pittsburg Valve Foundry and Construction Company, Pittsburg, Pa., and the motor and limit switch device were furnished by the Westinghouse Electric and Manufacturing Company.

NEW CATALOGUES.

Bulletin No. 4712 from the General Electric Company contains interesting data on the exhaust steam turbine.

Bulletin No. 53 from the Kellogg Switchboard & Supply Company illustrates and describes their multiple switchboards, presenting many valuable and interesting details of construction and installation.

The General Electric Company's Bulletin No. 4711, recently issued, treats of switchboard panels designed for small a. c. plants. The bulletin lists panels for two-phase and three-phase circuits, shows the connection diagrams for such panels, and gives dimensions and capacities.

The Rauch & Lang Carriage Company of Cleveland, Ohio, have issued their 1910 announcement of R. & L. electric carriages. This catalogue is of unusual size, its large pages readily lending themselves to an illustration and complete specification for each type of car described.

Bulletin No. 4713, recently issued by the General Electric Company, describes its Type F, Forms K-2 and K-4 Oil Switches, states their rupturing capacities contains diagrams of connections of those switches, and will be found of general interest to certain station managers and engineers.

The Garvin Machine Company, Spring and Varick streets, New York, N. Y., have issued an illustrated catalogue containing descriptions of hand lathes, spring coilers, cutter grinders, surface grinders, milling machine tools and attachments, screw machine tools and attachments, friction pulleys, countershafts, cone pulleys, hangers, and valuable tables of information.

In Bulletin No. 4706 recently issued by the General Electric Company is illustrated and described the company's type CR Curve-Drawing Ammeters and Voltmeters. This type of instrument gives a clear permanent record of the characteristics of the electric circuit to which it is applied and will be found of value in locating trouble with electrical apparatus in proving the efficiency of machines and workmen especially where the individual drive system has been adopted and in determining the correct size and style of the new machine. This instrument is suitable for use on either alternating or direct current.

The General Electric Company in Bulletin No. 4703-A, recently issued, describes its Variable Release Air Brake Equipment, which eliminates the defects usually found in the standard automatic air brake equipment for electric service. With the variable release equipment it is possible to handle a long train with nearly the same facility as single cars can be handled with the straight air brake system. The bulletin goes into considerable detail in describing this equipment, and shows cross sections of the valve when in different positions. This publication should be of interest and value to railroad men.

Gasolene-Electric Plants for Lighting and Power is the title of a very attractive publication just issued by the General Electric Company, which should be of great interest to those contemplating the installation of a small or isolated plant, or to those having country homes that are not within reach of the distributing circuit of a central station. As indicated by the title the pamphlet illustrates and describes complete generating units consisting of a direct current generator mounted on the shaft of a gas engine. These sets are attractive and are described in considerable detail. The pamphlet shows pictorially a number of the many uses to which current from such a set can be put. The number of the publication is 4707.

The Inland Portland Cement Company of Metaline, Washington, will install a plant consisting of two units, 1750 k. w. each, driven by Pelton water wheel.

NEWS NOTES

FINANCIAL.

GLENDALE, CAL.—The Trustees have voted to sell $14,000 worth of bonds to provide for the completion of a lighting department.

OAXACA, MEX.—Bonds for the new sewerage and water works system, amounting to one million eight hundred thousand pesos have been signed.

SAN JOSE, CAL.—The stockholders of the San Jose Railroad, the corporation which recently merged the street railways in this city, except the Interurban, have decided to issue bonds to the amount of $1,500,000.

HOLTVILLE, CAL.—The City Council has passed an ordinance calling an election to vote on the question of incurring an indebtedness in the sum of $37,000 for acquisition of water rights and the completion of waterworks. The election is to be held on January 28th.

BRAWLEY, CAL.—Sealed bids will be received until February 5 by the City Board of Trustees for the purchase of $44,000 of bonds voted December 28th for waterworks, etc. The bonds will be dated January 1, 1910, and bear interest at the rate of 5½ per cent per annum.

PHOENIX, ARIZ.—The Council of Tempe, Arizona, has memorialized Congress to permit the bonding of the town to permit construction of an electric lighting system to cost $25,000, to be ready for operation within two years when the present contract with Chandler will expire.

NEWPORT, CAL.—The City Council has passed an ordinance providing for the issuance and sale of bonds of the city in the sum of $65,000, $25,000 of which is to construct municipal light works and $40,000 for construction of water works for the city. The bonds will be of $1000 each and bear 5 per cent interest per annum.

INCORPORATIONS.

SEATTLE, WASH.—The Washington Fir Crossarm Company, capital $30,000, has been incorporated by W. M. Carpenter, John H. Neville and Ernest S. Hough.

RIVERSIDE, CAL.—The Moreno Water Company has been incorporated with a capital stock of $50,000, by D. S. Hayward, E. C. Bennett, J B. Maxwell and J. R. White.

ELBERTON, WASH.—The Elberton Milling & Power Company has been incorporated with a capital stock of $60,000 by Charles Hinchliff, Fred Hinchliff and Floyd Hinchliff.

NORTH YAKIMA, WASH.—Articles of incorporation of the Wenas Electric Power Company have been filed, with a capital stock of $15,000, by F. V. Sanders, L. J. Anderson, P. C. Weinman, M. B. Miles and E. G. Townsan. The company intends to build a power line into Wenas and supply power for pumping water for irrigation from the artesian wells of the valley.

PORTLAND, ORE.—Articles of incorporation of the Hood River Light & Power Company with a capital stock of $2,000,000, have been filed here. The papers provide for the construction of an electric railway from the mouth of Hood River to a point in the Mt. Hood District. Head offices are to be here, and the incorporators are: John D. Wilcox, a Portland real estate man; Wirt Minor, of the law firm of Teal & Minor, and R. Smith.

HONOLULU, H. T.—It has been practically decided by the directors of the Kauai Railway to issue $500,000 of 6 per cent 10-20-year bonds for the purpose of taking up the old issue and building the company's terminal at Port Allen. Of the old 6 per cent bond issue only about $80,000 were floated. These are to be taken up, or replaced by the new issue. The balance of the money is to be used for the company's terminal and other important improvements at Port Allen. George R. Carter says: "The scheme of improvements to be carried out, and for which the money is required, will greatly enhance the value of the road. This enterprise, by the way, is a going concern. That is to say, it already has the business and opportunities right at hand for much larger things. We are in urgent need of proper facilities at Port Allen, and the scheme now under way will fill the bill. The issue of bonds will be $500,000 and the rate will be 6 per cent. The bonds may be taken up any time after ten years and expire in 20 years."

TRANSMISSION.

PORTLAND, ORE.—The Oregon, Electric Company recently added a 500 k. w. rotary converter at Multnomah substation.

ENTIAT, WASH.—The Entiat Light & Power Company, Frank McKean, engineer, will put in two 1500 k. w. generators and water wheels.

SPOKANE, WASH.—The Big Bend Water Power Company, Paulsen Building, will build a 20,000 h. p. electric plant on the Spokane river 30 miles below the city.

DIXON, CAL.—Sealed bids will be received up to March 1st, at 8 p. m. for a franchise to erect poles and set wires for transmitting electricity along streets of this town.

CENTRALIA, WASH.—The Tenino Power & Water Company has made application for a franchise over the county roads of Lewis county for the purpose of telephone, telegraph and electric lines.

WALLA WALLA, WASH.—R. A. Stephenson of Mason City, Iowa, and C. E. Buell of Webster City, Iowa, contemplate building a large power plant on the Columbia river and are negotiating with prospective customers for power.

KENNEWICK, WASH.—The Yakima Valley Power Company will, according to report, connect this place and Pasco by means of a cable spanning the Columbia river and will for this purpose construct three 150 ft. steel towers.

PLACERVILLE, CAL.—T. A. Murray has filed notice of location and appropriation of 10,000 inches of water in Camp creek, flowing into the North Fork of the Cosumnes river. The location is for power, municipal irrigation and mining purposes.

CHICO, CAL.—According to A. W. Smith, secretary of the Sacramento Valley Power Company, that company will commence planting the poles for its distribution system in Chico during the present week. It is believed that the work can be completed within 30 days. Men have been engaged and the poles are now awaited.

OAKLAND, CAL.—The People's Electric Light & Power Company has filed a revised application for a franchise for electric transmission lines through the county of Alameda, and for the conducting of electricity for furnishing heat and power. The changes in the previous application were made necessary by the annexation election.

COTTAGE GROVE, ORE.—The Postal Telegraph & Cable Company, through its agent, H. M. Smith of Chicago, is contracting in this territory for 26,000 telegraph poles for the line across the continent from San Francisco. After this order is filled contracts will be made for poles to build a two wire line from San Francisco to Portland and Seattle.

RED BLUFF, CAL.—A notice of an appropriation of 15,000 inches of water in Cottonwood creek has been filed in the county recorder's office by the Rancho Buena Ventura. The real locator is Geo. L. Hoxie, one of the owners of the Rancho. The water is to be used on the northeast quarter of the northwest quarter of section 16, township 29 north, range 4 west, for irrigating purposes and generating electricity.

SEATTLE, WASH.—The Seattle Electric Company have completed and put in operation their new sub-station at Ballard. The equipment consists of two motor generator sets, one 500 k. w. and one 1000 k. w. and two 1000 k. w. transformers 13,000 to 22,000 volts. The new sub-station furnishes a. c. for power, d. c. for light and railway distribution. The company will change the 13,000 volt transmission line between Ballard and Everett to 60,000 volts. The company's new office building at Seventh and Olive streets, Seattle, will be ready for occupancy some time in April.

SACRAMENTO, CAL.—The Sacramento Gas, Electric & Railway Company is receiving material for the work of constructing conduits under the streets to replace the overhead wire system, in the part of the city lying between Fifth and Seventh, I and L streets. The district in which electric wires must be laid underground extends from Front to Twelfth, from I to L streets. This district is divided into three sections, one section to be cleared of overhead wires in 1910, the second section in 1911, and the third in 1912. The work will be under the charge of G. C. Holberton of the Pacific Gas & Electric Company.

REDDING, CAL.—W. D. Tillotson, attorney for the Mount Shasta Power Company, has filed six deeds and eleven agreements and assignments. One of these deeds is a transfer to the corporation of a water right of 200,000 inches of Pit river, in the Big Bend country. It is proposed to divert all this water through a tunnel seven miles long. This is H. V. Gates' project. By the papers filed H. V. Gates, R. E. Johnson and A. J. Treat consolidate their various interests in a corporation with a capital stock of $1,000,000. It is evident that the Mount Shasta Power Company is getting into a position where the active work of construction will be begun. The project involves the expenditure of several million dollars, and it will be one of the biggest undertakings of the kind on the Coast. The Big Bend of the Pit makes a 25-mile detour. The 7-mile tunnel will convey the whole river through the mountains and at its outlet will deliver water with such a great fall that 250,000 h. p. can be developed electrically.

TELEPHONE AND TELEGRAPH.

MEDFORD, ORE.—Estimates are being prepared for the construction of a telephone building for the Home Telephone Company.

VALE, ORE.—W. D. Baker has been granted a right of way by the county court for a telephone line over certain country roads.

LAMONT, WASH.—W. R. Hegler of this place has organized a telephone company and will also install an electric light system here.

VIRGINIA, MONT.—The Montana Independent Telephone Company has been granted a franchise by this place and work is to begin on the new plant at once.

WALLA WALLA, WASH.—Chas. Springer and others are interesting themselves in the project of building a telephone line between this place and Touchet.

MEDFORD, ORE.—Frank C. Clark, architect, of Ashland, is preparing plans for the building to be erected for the Independent Telephone Company.

MEDFORD, ORE.—The Medford & Butte Falls Telephone Company, B. H. Harris, has made arrangements with the Pacific Telephone Company to build to Central Point.

CRANBROOK, B. C.—The Kootenay Telephone Company will in the spring build from here to Kingsgate, where connections will be made with the Rocky Mountain Bell Company.

ASHLAND, ORE.—In celebration of the completion of direct telegraph communication between Ashland and Klamath Falls, city officials have sent greetings to those of the Klamath county capital.

IRONDALE, WASH.—The Sunset Telephone Company will put in an exchange here, also one at Quilcene. The improvements to be made by the Sunset in the country districts will amount to $6,000 to $8,000.

WINNEMUCCA, NEV.—J. E. Webb of the Golconda Telephone, Light & Power Company, accompanied by F. Murray has been in town completing arrangements to install a switchboard and local telephone system here.

BURNS, ORE.—The Union Telephone & Telegraph Company has been incorporated, with its principal office at Burns; capital stock $5000. incorporators: J. H. Jordan, John Jenkins, C. H. Voegtly and L. E. Laurance.

CERES, CAL.—The Ceres Telephone Company contemplates beginning work in a few days on the extension of its system toward the Crows Landing road country. It is reported this extension will include five miles of wiring.

SEATTLE, WASH.—The Home Telephone Company of Seattle are making extensive additions to their central switchboard and putting in a new long distance switchboard of the most modern construction. They are also enlarging their switchboard at Green Lake Station to care for increased business.

TWIN BRIDGES, MONT.—An ordinance has been passed granting the Montana Independent Telephone Company the right to enter the town and it is understood that work will be commenced at once extending the line from Whitehall to this place and thence to Dillon. It is also reported that a branch will be built up the valley to Sheridan and Virginia City.

ILLUMINATION.

NEWCASTLE, CAL.—An election will be held February 3d to decide whether a public highway lighting district shall be formed, as provided by the recent act of the Legislature.

VALLEJO, CAL.—Improvements involving the expenditure of $60,000, which, when complete, will make the local gas works the finest in any city of this size in the State, have been begun by the Pacific Gas Company.

SANTA BARBARA, CAL.—It has become known that the Edison Company will spend $211,000 for a new gas plant, four times the size of the present one. About $150,000 more will be devoted to the extension and improvement of the local trolley system.

VENICE, CAL.—Merchants of Venice have taken the initiative in a movement to organize a local corporation to establish an independent gas system. J. M. White, E. W. Smith and Thomas Taylor have started out to sound public sentiment. They will report back at the meeting in two weeks.

REDLANDS, CAL.—H. B. Duncan, secretary of the San Bernardino Valley Gas Company, states that the company will construct a generating plant at Colton to manufacture gas to be used in Colton, Redlands, and at the San Barnardino plant. Should it be advisable the company will construct a high pressure line from Colton to Corona.

SAN RAFAEL, CAL.—The gas company has received a large consignment of pipe from the East and has it stored in Ross. The gas company will in the near future extend its gas mains from San Rafael to Ross and probably further. San Anselmo was the first town to sign up for gas and therefore will be the first to have the connections made.

TRANSPORTATION.

OSWEGO, ORE.—The Portland Light & Power Company will construct a line from West Oregon City to Oswego a distance of four miles.

PORTLAND, ORE.—Standard gauging of two miles of street railway in East Portland is under consideration by the Portland Railway, Light & Power Company and will probably be ordered in the near future.

REDONDO, CAL.—The announcement that the Pacific Light & Power Company is soon to double the capacity of its big plant here has renewed the report that the Los Angeles and Redondo Railway will extend its line south to San Pedro. A right of way has been secured.

WOODLAWN, ORE.—The Valley Railway Company has just completed three miles of track between Woodburn and West Woodburn connecting with the Oregon Electric Railway at the latter place. The new line will be operated about February 1st by the Oregon Electric Company.

OAKLAND, CAL.—The Supervisors have received and filed with the roads, bridges and franchise committee an application from the Southern Pacific Company for a franchise to construct and operate an electric railroad from Albany to Berkeley as part of its present interurban railroad system between Berkeley and San Francisco.

SACRAMENTO, CAL.—Nine suits for rights of way for the line to be run between Lodi and Sacramento have been filed by the Central California Traction Company. The property owners are J. W. Reynolds, A. J. Neves, R. J. Neves, C. M. Dillard, J. L. Martin, Kate Costella, Ugo Pechler, James Soukup, T. Ikedo and T. Sato. Their property lies in Goethe Colony No. 13.

SAN FRANCISCO, CAL.—The San Francisco Board of Supervisors have passed the vote with the approval of Mayor Taylor to grant a franchise for a term of 25 years over Gough street from McAllister to Market and Haight to the United Railroads Company. The railway company desired this franchise for the purpose of a route which would avoid the Fillmore street hill.

LOS ANGELES, CAL.—Within ten days grading for the Pacific Electric Railway will be completed through Claremont, then rails will be laid connecting that city with Upland. The Pomona right of way committee has effected a compromise with the orange growers at North Pomona through whose grove the line is to be laid, with the exception of one ranch. When this is adjusted there will be nothing to hinder the completion of the main line to Covina.

FRESNO, CAL.—The Supervisors have received application from the San Francisco firm of Gilmore & Lennon for a franchise to construct and operate a railroad between here and Coalinga. This is the third of the kind within three months. A direct route from Fresno to Coalinga has been a favorite topic of discussion among local capitalists ever since the wealth of Coalinga oil fields was demonstrated. At present the old town can be reached only by one route, the Southern Pacific, and the distance is 100 miles. This would be cut to 60 miles if the proposition now being advanced are carried out.

MEDFORD, ORE.—The Rogue River Valley electric line operated between Medford and Jacksonville, is to be extended from Jacksonville to Applegate Valley next spring; $125,000 is now being provided by bond issue placed with the Merchants' Loan and Trust Company of Portland, at 5 per cent interest. The road is owned by W. S. Barnum & Sons. Survey of the route has been made across the divide between Jackson Creek and Applegate River, the heaviest grade being 2.3 per cent route up Jackson Creek for two miles from Jacksonville, at which point it will cross the divide to Poorman Creek, and will terminate at Ruch for the present.

OAKLAND, CAL.—That the plans of the Southern Pacific Company to extend its electric system from Alameda to San Jose will be put in operation as soon as the lines on the east side of the bay are electricized is announced by a prominent railroad official. According to the official's information, the Southern Pacific Company will make use of the old narrow-gauge right of way across Bay Farm Island to the mainland, thence down the east side of the bay to San Jose. The right of way is owned by the railroad. A portion of the trestle is still intact and the roadbed is in good condition across the island and needs only tracks of standard gauge to make it suitable for traffic.

WATERWORKS.

LODI, CAL.—The Trustees have decided to construct a municipal water plant.

BEVERLY, WASH.—Bates & Clark, engineers of Seattle, Wash., are putting in a 200 h. p. steam pumping plant for the Rose Land Company at Beverly.

SILVER CITY, N. M.—The Silver City Valley Water Company of this city has let a contract for sinking of a 500 foot 12-inch well just north of town.

SAN FRANCISCO, CAL.—Sealed proposals, in triplicate, will be received at Fort Mason up to 11 a. m. February 1, 1910, for constructing water and sewer systems, including grading around officers' quarters at Presidio of San Francisco.

VALE, ORE.—A contract has been entered between the city of Vale and Parrott, Cottrell & Parrott of Baker City, in which the city employs these engineers to make surveys, draw plans, mark the surveys on the ground, find the best water supply, and make estimates for a complete water system.

EVERETT, WASH.—A move for municipal ownership of the water system has been begun by Councilman Phillips, who has introduced a resolution instructing the mayor to appoint three members of the City Council and the city engineer to investigate the cost and employ a reliable engineer to secure a source of supply and plan a system of mains, etc.

PORTERVILLE, CAL.—At a meeting of the Rosedale Water Company held on January 12th, the following members of the company were chosen for the board of directors: J. A. Milligan, E. L. Sloan, F. D. Bailey, B. L. Carpenter, J. H. Orr. The directors organized and chose for the year, J. A. Milligan as the president and E. L. Sloan as the secretary.

SACRAMENTO, CAL.—The East Sacramento Water Company plans a meeting to decide on a site for its wells, to get bids for boring, select plans for towers, buildings and other adjuncts and to discuss getting a franchise from the county. The company hopes to supply water, gas and electricity to East Sacramento and other outside sections, but not to Sacramento.

GRASS VALLEY, CAL.—Announcement is made that the South Yuba Water Company is ready to carry out the promise given a year ago relative to piping and fluming water through certain sections of the ditch now supplying the city reservoirs, thus giving the town a supply of pure water. City Engineer Miller will shortly go over the ditch in question and map the portions where pipes or flumes are necessary.

CENTRALIA, WASH.—The Centralia-Chehalis Water & Power Supply Company has filed articles of incorporation, for the purpose of constructing a pipe line conveying water from the Newaukum river to the water supply systems in Centralia and Chehalis, thus giving the two cities gravity water plants. The cost of the line will be $200,000. The officers of the company are John E. Heasty, L. W. Goodrich, E. S. Price, F. S. Blarner, Clayton W. Quale.